

38.1

OCTOBER 2019

THE AVALANCHE REVIEW

A NOTABLE WINTER

After a storm, photographer Charley Nish captured this shot of sunrise over the Cabinet Mountains, ID, a central part of the Idaho Panhandle Avalanche Center's northern forecast zone.

Avalanche Center Season Summaries
Page 26



AMERICAN
AVALANCHE
ASSOCIATION

How Risky is Ski Cutting?
Page 20

Are We Teaching Confidence Over Competence?
Page 17

25 YEARS DEEP

We've been neck deep in snow safety for 25 years. It's all we do. We make proven, easy-to-use backcountry products like Float, the bestselling avalanche airbags in North America. And it's all backed up with education and knowledgeable customer service.



FLOAT 32

Light, affordable, easy to refill.

Apply for a pro account here:
www.backcountryaccess.com/pro



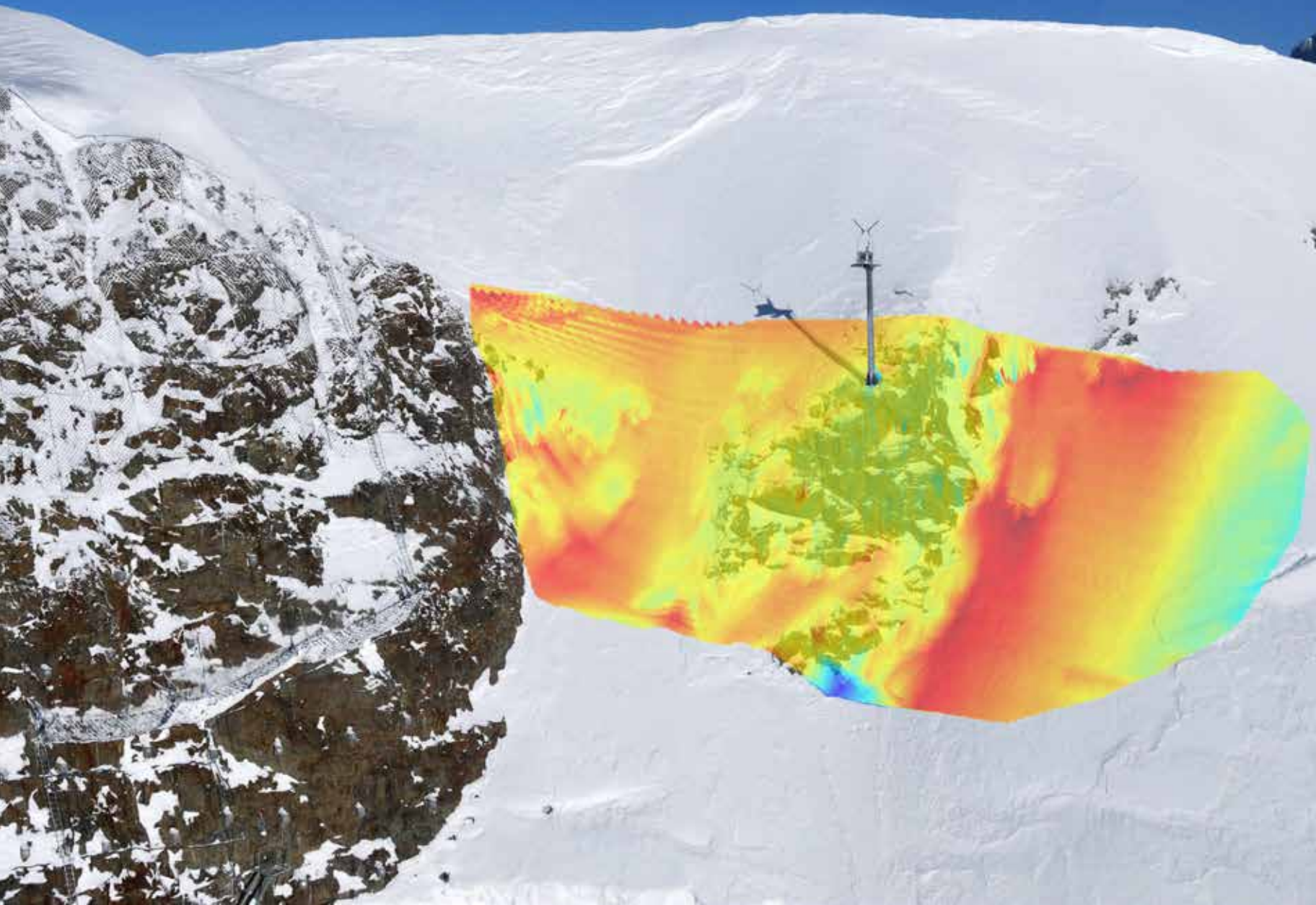
**The most trusted name
in backcountry safety.™**

Est. 1994

Laser Impulse Snow Height Acquisition

LIA[®]

3D Laser measurement of changes
in snow accumulations in the
avalanche release area



**avalanche
control**

Wyssen USA Inc.
80301 Boulder CO
+ 1 208 891 95 43
usa@wyssen.com
www.wyssen.com

Shell, Yeah!



Photo: BERND ZEUGSWETTER © 2019 Patagonia, Inc.



Performance. Fair Trade Certified™ sewn. Built with recycled materials.
Every waterproof shell we make.

patagonia®

38.1 | CONTENTS

THE SEASON SUMMARY ISSUE



AMERICAN
AVALANCHE
ASSOCIATION

FEATURE STORIES

- 24 A Reflection on a Notable Winter by Roz Reynolds
- 26 A Notable Winter: Avalanche Center Season Summaries

NAC.....26	COAC.....34	KAC.....41
NWAC.....27	GNFAIC.....34	CBAC.....41
IPAC.....28	BTAC.....35	CAIC.....42
FAC.....29	UAC.....36	MWAC.....44
PAC.....30	MSAC.....37	CNFAIC.....45
WCMAC.....31	TSAC.....38	AAIC.....45
SAC.....32	ESAC.....39	
WAC.....33	BAC.....40	

DEPARTMENTS

- 6 From A3 News
- 10 Metamorphism
- 49 Book Review: Go Find by Christine Hensleigh
- Education
- 17 Are We Teaching Confidence Over Competence? by Dave Richards
- Snow Science
- 20 How Risky is Ski Cutting by Avalanche Practitioners? by Bruce Jamieson et al.
- 48 Avalanche Airbags and the Ability to Create and Air Pocket and Delay Asphyxiation by McIntosh, Polukoff, Little, Seibert, and Grissom

A3 STATEMENT OF PURPOSE

The American Avalanche Association promotes and supports professionalism and excellence in avalanche safety, education, and research in the United States.

A3 STAFF AND BOARD

Executive Director.....Dan Kaveney
Pro Training Coordinator.....Kate Koons

A3 Governing Board Trustees

President*.....Halsted Morris
Vice President*.....Erich Peitzsch
Secretary*.....Katie Johnston
Treasurer*.....Pete Woodring
Membership*.....Jake Hutchinson
Publications.....Drew Pogge
Education.....Eeva Latosuo
Governance.....Tom Mattice
At-Large Pro.....Sean Zimmerman-Wall
Member Affiliate.....Jonathan Shefftz

*Executive Committee denoted by **

Editor.....Lynne Wolfe

Editors Emeriti

Steve Conger
Sue Ferguson
Blase Reardon
Bruce Tremper

THE AVALANCHE REVIEW

The *Avalanche Review* is published each fall through spring by the American Avalanche Association, Inc., a nonprofit corporation. The *Avalanche Review* welcomes the submission of articles, photographs, and illustrations.

Please send submissions to:

Lynne Wolfe — Editor
tel: (208) 709-4073
avalanche.review@avalanche.org

Design & Production:

McKenzie Long — Designer
tel: (513) 515-0723
mckenzie@cardinalinnovative.com

Business, Subscriptions, & Advertising:

Dan Kaveney — A3 Executive Director
tel: (307) 264-5924
dan@avalanche.org

Subscription: \$35 per year (4 issues). Subscription is included with membership dues to A3. For subscription and membership information, see www.AmericanAvalancheAssociation.org.

Articles, including editorials, appearing in *The Avalanche Review* reflect the individual views of the authors and not the official points of view adopted by A3 or the organizations with which the authors are affiliated unless otherwise stated.

© 2019 by the American Avalanche Association.

Materials may be reproduced for research or classroom use. Permission is also granted for use of short quotations, figures, and tables in scientific books and journals. For permission for other uses, contact *The Avalanche Review*.

WE ARE SKIERS.

THESE ARE THE GLOVES WE USE.



HAND BAKED IN COLORADO

Our Tough Glove gloves are hand-baked and treated with waterproofing Sno-Seal bees wax so they're ready for whatever the day brings.



Independent
Homegrown
Mountain Raised
FLYLOWGEAR.COM

KEEP YOUR A3 MEMBERSHIP PROFILE UPDATED!

Your **Wild Apricot** profile houses all the information we need to keep in touch with you. If your profile goes out of date you will no longer receive your copy of *The Avalanche Review* or email communications from A3. A number of you have emails and surface addresses in your profiles that are no longer valid. Please log in to your profile at <https://aaa19.wildapricot.org> and make sure you're up to date. If you have any trouble, please contact Dan@avalanche.org for assistance.

TAR THEMES AND ROLLING DEADLINES FOR SUBMISSIONS:

38.2: December 2019 due Oct 1–15
Theme: any topic!

38.3: February 2020 due Dec 1–15
Theme: fracture mechanics

38.4: April 2020 due Feb 1–15
Themes: human factors and decision-making

A FEW FAVORITE PODCASTS AND AVY EDUCATION LINKS

BY LLOYD MORSETT

PODCASTS Some are current and putting out new info; some have not put out new content in a while but are still searchable and worthwhile.

- **The Avalanche Hour**, Hosted by Caleb Merrill
- **Slide: The Avalanche Podcast**, Hosted by Doug Krause
- **Utah Avalanche Center Podcast**, Hosted by the UAC's Drew Hardesty
- **Send and Return**, Hosted by BCA
- **Totally Deep**, Lou Dawson and Wild Snow

YOUTUBE CHANNELS There are a million of them including all the regional avy centers, but some good education on these in particular:

- **AvalancheGuys**: multi-media presentations from professional seminars, dash-board talks
- **National Avalanche Center**: Great educational videos
- **Northwest Avalanche Center**: Broadcast talks from NSAW
- **Backcountry Access**: Safety and Equipment: Education, How-tos, and product info
- **American Avalanche Institute**: great educational videos
- **AIARE Online Learning**: educational videos

Lloyd Morsett is busy between his duties with the Friends of the Flathead Avalanche Center Board of Directors, Northern Rockies Snow and Avalanche Workshop Steering Committee Chair, and Whitefish Mountain Resort Snow Safety Coordinator.

FROM THE EDITOR

BY LYNNE WOLFE

Welcome to the first issue of our 38th season of *The Avalanche Review*. The first thing you might notice is our extra heft. Our tenacious ED brought in more ads from our business supporters, so we added four more pages so not to skimp on the content that you expect from TAR. These advertisers not only bring great images to our pages, they support our association and allow us to represent you better. We know you have lots of choices when buying your avalanche-related products; please remember with your dollars the companies who keep A3 in the game.

You'll find this issue's column from our A3 president, Halsted Morris, on page 9. He has tackled head-on the ticklish issues of gender equality in our industry and community, and I applaud his honesty. Let's work to incorporate alternative perspectives and voices into our practices.

We begin our new season with a critical review of the previous winter, which was remarkable and record-breaking on many fronts. Our question for the forecasters in writing their season summaries was,

“What were your forecasting challenges for this notable winter?”

I pay close attention to the patterns that emerge from reading many 1000-word summaries of an entire season. How other avalanche workers recognize and then deal with those situations can help me make more informed decisions in my practice and especially in my communications. Last year's patterns brought deep snow and large avalanche cycles, which translated into good stories and great photos; a few jumped out at me in this batch.


From Colorado's winter of excesses, I am reminded of how unusual conditions bring unusual avalanches. Record-breaking snowfall and avalanches force us to adapt practices while maintaining margin in unpredictable circumstances. Kudos to our colleagues throughout the West and especially at CAIC and CDOT for their hard work as the snow kept falling.

In Utah, in a spate of backcountry traveler fatalities, three sledders and a skier weren't even carrying the basic complement of backcountry gear (beacon, shovel, probe). But a conversation with the UAC's Mark Staples takes me deeper than the numbers into a more nuanced understanding of the long-term success of our avalanche message in infiltrating mainstream culture.

From the Bridger-Teton summary I note stories of another sledder buried without a beacon, then two separate accidents with complete burial and subsequent fatality even though the victims deployed airbags. No silver bullets; statistics once again underline the basics.

In addition to our annual avalanche center season summaries (plus a bonus overview summary from world traveler Roz Reynolds), you'll find an array of other stories: from Bruce Jamieson's ski cutting survey results to Dave Richards' self-described rant about confidence vs competence, to some timely research about airbags.



Autumn begins the SAW season, where we tune up our brains, get our thought processes ready to interpret the patterns of a new snowpack. I'll be on the SAW circuit this year—hope to see you at NSAW, WYSAW, or Bend-SAW, representing A3 and discussing the art of debriefing. Let me know what piques your curiosity, gets you thinking and talking, and what is worthy enough to incorporate into your everyday rituals. 

FROM THE EXECUTIVE DIRECTOR

BY DAN KAVENEY

Time flies when you're hard at it, especially if you're having fun. That rings true for me as I sit down to write my second column for *The Avalanche Review*. How could it possibly have been almost exactly one year since I sat down to write my first? I don't know, but I'm glad to be able to report that it was a good year for the American Avalanche Association. A year ago this column put forward the board's view that our organization needed to spend the next 12 months working toward expanding our reach while simultaneously grounding ourselves on a firmer financial footing. We had hoped to begin by recruiting new members, improving the volume and productivity of our relationships with corporate sponsors, continuing our focus on strong publishing, staying focused on the Pro Training Program, and expanding our outreach and professional development activities.

We did our best to follow through on these goals, and, thanks to your help and engagement, these initiatives yielded significant gains for A3. We doubled our corporate support, more than doubled our donations, and enjoyed a 35% increase in membership dues that resulted from increased membership. We diminished expenses by 6% while simultaneously increasing support for professional development activities, scholarships, research, and outreach initiatives, and, for the first time in a number of years, we finished the season with a small surplus. These successes have allowed us to begin 2019/20 with ambitions to further expand our activities in support of the avalanche community.

The purpose of building a strong foundation for the organization is to better serve the avalanche community, and during the 2018/19 season we made progress improving our support for quite a few important avalanche-related things. Some highlights include:

- Offering financial support to 12 Snow and Avalanche Workshops across the country.
- Sponsoring the ISSW 2018 in Innsbruck, Austria.
- Awarding two members scholarships and travel stipends to attend ISSW.
- Awarding two research grants to promising young avalanche researchers.
- Coordinating the second—and the beginning of the third—season of the pro training program.
- Helping increase avalanche.org traffic by about 40% to almost 1.5 million unique visitations last winter, and increasing our social media outreach dramatically. Some of our best social media posts now garner as many as 30,000 interactions.
- Adding hundreds of **new members**.

- Distributing 4 terrific issues of *The Avalanche Review*, and selling and shipping hundreds of copies of *The Snowy Torrents*, *Snow Weather and Avalanche Guidelines*, and quick reference stickers.

We plan to continue to increase our service to the avalanche community this coming year. Key initiatives for the 2020/21 season include:

- A revised research grant program that will increase A3 support for research while simultaneously giving both A3 and applicants more discretion in applying for and awarding research grants.
- Increasing A3 support for Snow and Avalanche Workshops by 35%.
- Putting out a call for interested parties to apply to join the Pro Training Program as Pro Providers, beginning during the 2020/21 season.
- Introducing new membership and giving initiatives that we hope will allow us to continue to increase A3 membership and charitable giving.
- Building on our partnership with the US Forest Service to expand avalanche.org as both an outreach platform and as a tool for avalanche forecasters.
- Increasing our various outreach efforts via publishing, avalanche.org, and social media.
- Continuing our sponsorship of the ISSW by promoting and supporting ISSW 2020 to be held in Fernie, BC, and by offering scholarships to A3 members for attendance.

I'll close by saying thank you. It has been a whirlwind year, and I can't thank all of you enough for your engagement, your daily efforts, and the welcome you've rolled out for me. I owe the board of directors a profound debt of gratitude for their hard work and support – and for giving me a kick every now and again when I needed it to stay on course. The A3 in general, and I in particular, owe some appreciation to the staff and contractors who give their all to this organization: Kate Koons, Pro Training Coordinator; Lynne Wolfe, Editor of *The Avalanche Review*; McKenzie Long, Graphic Designer; Dawn Smith, Bookkeeper; and Will Flynn, Social Media Intern and Coordinator. Thank you.

I'm always very interested in learning your ideas about how to move the organization forward. I'll be attending as many SAWs as I can this fall, and I look forward to meeting as many of you as possible while doing this. In the meantime I can best be reached at dan@avalanche.org, or at 307.264.5924. 📞



A3 NEW PRO MEMBERS

Mark Alpes
Gabrielle Antonioli
Melan Arcienno
Ryan Ayres
Bruce Babbitt
Sebastian Barlerin
Will Barrett
Stephen Bass
Bradley Beckstead
Zach Behney
David Belding
Bryan Bennett
James Bernstein
Jason Bilek
Kurt Blair
Charles Bledsoe
Chelsea Bomba
Tyson Bradley
Rebecca Briber
Harrison Brickman
David Brown
Wesley Calkins
Arturo Carrasco
Nathan Chaszeyka
Everett Coba
Meredith Condon
Jon Conway
Clint Cook
Shane Coolidge

Jonathan Cooper
Mike Coyle
Pedro Crespo
Reggie Crist
Jonathan Cromwell
Gregory Cunningham
Adam Davis
Alan Davis
Weston Deutschlandler
Kevin Dombrock
John Douglas
William Dryer
Christopher Dunbar
Katelin Duncan
Michael Elges
Patrick English
Tyler Falk
Bryan Ferguson
Luciano Fiorenza
Charles Fogg
Michael Fogg
Paul Forward
Evan G. Miller
Peter Ginsbury
Nathaniel Goodman
Alan Gordon
Thomas Gram
Doug Griesel
Pete Groves

Andrew Guzman
Jon Hageness
Nina Hance
Jason Holton
Ryan Johnson
Stuart Johnson
Spencer Jonas
Graham Kane
Jacob Kayes
Kirsten Kramer
Kevin Krein
Dungan, Kyle
Michael Lackman
Drew Layman
Caleb Leland
Cameron Mackenzie
Claudio Margaride
Benjamin Markhart
William Marsh
Chris Martin
Timothy Matthews
Chris Mayer
Eric McCue
Zackary McGill
Joshua McKnight
Evin McNeil
Arturo Mencia Cristobal
Tom Meyer
Christoph Mitterer

Nathan Moody
Peter Moore
Michelle Mulder
Ryan Murray
Craig Muterlak
Michael Nash
Nicholas Nason
Sarah Newsome
Arran Nichol
Francis Olive
James Orlet
Erica Pacall
Zach Paley
Tony Pavlantos
Christopher Peterson
Andrew Pierce
Steve Porcella
Eric Porter
Bill Radecky
Shannon Regan
David Rice
Chris Robertson
Sam Roche
Mikhail Ryabchikov
Morgan Sadler
Emiliano Salomon
Dan Sandberg
Bruce Saxman
Braden Schmidt

Elizabeth Schwab
Shan Sethna
Sam Seward
Edward Shanley
Stephen Showalter
Dave Shuey
Ryan Sorenson
Mark Speichert
Tim Stephens
Chris Stillwell
Jeffrey Troyer
Daniel Turner
Andras Vegh
Tara Vessella
Michael Wachs
Alexander Walker
Courtney Walton
Tom Wayes
Mike Wenner
Phil White
Thomas White
Jeremy Wood
Blayne Woods

Congratulations to our new pro members inducted between July 1, 2018 through the 2019 second quarter board meeting. If you don't see your name here and you think you should please write dan@avalanche.org.

A3'S CERTIFIED INSTRUCTOR PROGRAM: END OF AN ERA

A3 CERTIFIED INSTRUCTOR LIST

Kirk Bachman 2006
 Ned Bair 2015
 Paul Baugher 2009
 Markus Beck 2016
 Wm. David Beck 2003
 James Marc Beverly 2008
 Ken Bokelund 2009
 Tyson Bradley 2003
 Dave Budge 2014
 Dean Cardinale 2004
 Don Carpenter 2009
 Sarah Carpenter 2008
 Sarah Carter 2016
 Tom Carter 2003
 Doug Chabot 2013
 Mike Cooperstein 2009
 Kevin Davis 2016
 R.L. Sam Davis 2003
 Mike Duffy 2016
 Kelly Elder 2004
 Kellie Erwin-Rhoads 2004
 Mark Falender 2011
 Tim Farrar 2009
 Mark E. Fisher 2008
 Liam Fitzgerald 2006
 Michael B. Friedman 2007
 Eric Geisler 2011
 Andy J. Gleason 2009
 Bill Glude 2004
 Ethan Greene 2003
 Jerry Hance 2003
 Larry Heywood 2008
 Mathew M. Hill 2006
 Denny Hogan 2003
 Jake Hutchinson 2006
 Dudley Improta 2012
 Michael Jackson 2007
 Michael Janes 2016
 Ron Johnson 2008
 Aleph Johnston-Bloom 2011
 Timothy Keating 2008
 Janet K. Kellam 2003
 Tom Kimbrough 2006
 Eric Knoff 2016
 Sandy Kobrock 2003
 Douglas Krause 2009
 Gary A. Kuehn 2012
 Eeva Latosuo 2011
 Tom Leonard 2009
 David W. Lovejoy 2007
 Chris Lundy 2013
 Ron Matous 2006
 Thomas E. Mattice 2009
 Ian McCammon 2005
 Colin Mitchell 2013
 Dan Moroz 2004
 Patty Morrison 2015
 Gary L. Murphy 2007
 Tom P. Murphy 2006
 Mark Newcomb 2006
 Rod Newcomb 2003
 Craig Patterson 2010
 Erich Peitzsch 2015
 Dick Penniman 2003
 Nancy Pfeiffer 2007
 Ben Pritchett 2012
 Billy Rankin 2012
 Blase Reardon 2011
 Douglas P. Richmond 2006
 Santiago Rodriguez 2009
 Chuck Rose 2003
 Mike Ruth 2009
 Evan Salke 2005
 Scott Savage 2013
 Brad Sawtell 2007
 Kent Scheler 2011
 Matt Schonwald 2014
 Donald Sharaf 2003
 Blaine Smith 2007
 Mark Staples 2014
 Richard (Ted) Steiner 2013
 Craig L. Sterbenz 2006
 John Stimberis 2010
 Joe Stock 2016
 Spencer Storm 2012
 Tom Thorn 2010
 Scott M. Toepfer 2007
 Lel Tone 2013
 Toby Weed 2007
 Lynne Wolfe 2003
 Jamie Wolter 2009
 Jim Woodmencey 2007
 Ricky L. Wyatt 2006

BY JAKE HUTCHINSON


It's been a pleasure, mostly. I took over the A3 Certified Instructor (CI) program from Brad Sawtell more years ago than I remember. It was at a time when a bunch of changes and improvements to the program were in the works and the future looked a little intimidating. Proposals went out, discussions were had, and a path to making the CI program a true certification seemed challenging but clear and then we hit the brakes.

The White Paper and subsequent proposal to split Professional and Recreational Avalanche Education was the catalyst. The working group and the A3 board agreed that any changes to the CI program should be delayed until the dust settled on the Pro/Rec split and we could define where the CI fit into the new paradigm.

As we begin to prep for the third season of the Pro/Rec split, it is time to announce the A3 CI program will be discontinued. It was conceived and implemented in a time when the Pro/Rec split was a vague idea argued over in bars and social hour at ISSW. At the time it was the top of the mountain, representing the most experienced, most qualified avalanche instructors in the US. A look at the list today reflects a who's who of the US avalanche community—from mountain guides to forecasters and ski patrollers.

Last fall, after many years of debate and discussion with providers and CIs, the Ed Comm voted to discontinue the program; the reality is that it doesn't cleanly fit into the new structure anywhere. There was little motivation from education providers to support or require the program in any form. From the Ed Comm, the proposal went to the Governing Board in Spring 2019, where we voted to pass the Ed Comm's recommendation and end the program.

Moving forward—The A3 will continue to maintain **the list of those who went through the process**—recognizing their achievement as the highest available at the time. We have some website references and language to clean up and a few other loose ends to tie, but I am proud to officially retire the hat of A3 Certified Instructor Rep and focus on growing the membership of A3 as Membership Rep to the Board. This move also allows the A3 to focus resources on the Pro Trainer Program, which I believe will do more for avalanche professionals long term than the CI program could. Many of the CIs are now on the list of those instructors who have gone through the training and are qualified to teach at the Pro Course level.

As always, email me with questions, insults, or general harassment at jmhutch24@gmail.com. Thanks for giving me the opportunity to serve in this role for so many years. 

Jake Hutchinson is an instructor for AAI and the A3 Membership Trustee, currently involved in animal testing to see if he learned anything from all those great dog teams he trained with over the last 27 years...





MAMMUT
 SWISS 1862

**WHEN TIME IS YOUR ENEMY,
 FAST IS YOUR FRIEND.**

OUR MOST ADVANCED AVALANCHE BEACON EVER

POWERFUL. EASY. FAST. – BARRYVOX®S.

MADE IN SWITZERLAND 

MAMMUT.COM

FROM THE PRESIDENT

BY HALSTED "HACKSAW" MORRIS

This summer I was reading in *Climbing Magazine* (June/July issue) an article about women mountain guides. I found the article to be fairly depressing in the low number of certified women mountain guides in the USA. It was equally embarrassing the way a number of these women have been treated in the "workplace."

Apparently, I wasn't the only person thinking about sexual discrimination/harassment in the guiding and avalanche industry. *The Canadian Avalanche Journal* in their July issue had an article (Diversity and Mental Health, by Rachel Reimer) about equality, inclusiveness, diversity, and mental health in the guiding and avalanche industry. These are important issues that we face and shouldn't be taken lightly. I encourage you to read both articles.

Over the years I have met and worked with a number of female avalanche professionals: ski patrollers, ski patrol directors, heliski-guides, avalanche educators, highway avalanche forecasters, SAW/ISSW presenters, rescue dog handlers, S&R members, and A3 board members. Ladies, did I leave anyone out? For me I have always enjoyed the interaction and felt mutual respect. I'm proud to call many of these women true friends. In the past A3 hasn't tracked the demographics of male/female, so I can't really tell you how many women members of A3 there are. We'll work on this.

Sue Ferguson started *The Avalanche Review* in 1983 and served for five years as editor/co-editor. She essentially helped start the American Association of Avalanche Professionals (AAAP), through *The Avalanche Review*. Looking back at our roots, it's clear that women have played a major role in A3 and the avalanche industry. A3 needs to become more than just the "old-boys" avalanche club.

I have contacted several women A3 members and asked for their advice on what A3 can do to encourage more inclusion and respect for women in A3. The A3's support of the "Avalanche Divas" events at ISSW has been one way, which shall continue. The Divas events have proved the value of mentorship programs. I'd like to see more scholarships to events like ISSW for women too. But we should do more and I'm open for suggestions you may have.

Last winter, I did an in-depth avalanche talk at the 48th Annual Rocky Mountain Lift Association (RMLA) in Grand Junction, CO. Over the years, I've taught courses for everyone from Boy Scouts to Homeland Security agents. I've been able to adapt my presentations to meet the audience needs. The avalanche industry is a wide and diverse group of people, and we serve a wide and diverse population. That's why I feel everyone in our business deserves respect at all times.

A3 is the best American resource for keeping up with what's happening in the avalanche world. We also want to be the primary resource for networking and mentoring in the American avalanche world, contributing to the professionalism of our members. This is why all snow professionals should be members of A3. **A3 is your association, no matter what your gender.** ●



Our Professional product collection is specifically configured for mountain professionals. Drawing on over 50 years of collective design expertise, we work extensively with guides, rescue teams, and snow safety personnel to determine their needs and identify equipment solutions.



A3 is your association, no matter what your gender.

HANS BERG ADDED TO A3 MEMORIAL LIST

BY HALSTED "HACKSAW" MORRIS

On March 07, 2019, Hans Berg was killed in an avalanche while working as a mechanized ski guide for Powder Addiction Snowcats, at Jones Pass in Colorado. His death fits the approved criteria for inclusion on the A3 memorial list.

Details of the accident can be found at https://avalanche.org/accident-report/?accident_id=725

On behalf of the A3, I would like to express our condolences to Hans's friend and family.

The addition of Hans's name to the Memorial List brings the total number of people listed to 73. This is the first addition to the list since 2017. The Memorial List will be updated on the A3 website.



Photo and anecdote by Randy Wheelock

We were skiing Berthoud Pass this morning and conditions were ideal, 16-18 of overnight and Colorado bluebird skies. Hans dropped in and about his 3rd or 4th turn, he kicked his ski. We looked for what seemed like hours on this perfect morning, and in reality it was about five minutes before Hans said, "I've got another set in the car, let's go!" He skied the rest of the pitch on one ski and his stoke never dropped below incredible.

This image was snapped at the parking lot heading back to grab his other set of skis so we could take advantage of the kind of day that gives us memories and friends for life! ●

COURSE UPDATE

Alaska Guide Collective

The Alaska Guide Collective was formed in 2016 by Joe Stock, Nick D'Alessio, and Elliot Gaddy as a way to allow us to operate as independent mountain guides throughout Alaska. After a couple of seasons of operation and seeing a desire for more avalanche training opportunities in the community, we decided to offer some public avalanche courses around Anchorage. A3 approved our curriculum and we started offering courses in the winter of 18/19.

Following a successful inaugural season, where we taught two full enrollment recreational courses, the Alaska Guide Collective will be offering more Rec 1 and Rec 2 avalanche courses for the upcoming winter. Last year's students expressed their appreciation of the current course format, with mid-week night classes being offered at the Alaska Rock Gym and full field days in Turnagain Pass south of Anchorage.

Our teaching staff is composed of experienced avalanche educators. We have developed our own curriculum for courses based off of our experience as recreational skiers and climbers and as mountain guides. Courses operate at a 5:1 ratio and within the AMGA's scope of practice guidelines. Nick and Joe are certified ski guides.

We hope to continue offering more course opportunities to the snow recreation crowd around Anchorage, and providing the best educational experience we can to our students.



Nick listens to a student question in a pit during a Rec Level 2. Photo courtesy of AGC, by Ralph Kristopher

METAMORPHISM

Gallatin National Forest Avalanche Center

The Gallatin National Forest Avalanche Center welcomes **Dave Zinn** to fill the forecaster role formerly held by Eric Knoff. Eric has decided to leave the GNFAC after ten winters of forecasting and teaching avalanche classes. He is now focusing his winter efforts on avalanche education, and has founded Six Points Avalanche Education with fellow rider, skier and educator, Bill Radecky. Visit their website at www.avalanche-class.com for more info. We will miss Eric's expertise and superb powder-seeking skills. We will do our best to keep our team's snowmobile face-shots to stuck ratio high, but it will not be easy without Eric.



Dave joins the GNFAC with a B.A. from the University of Oregon (2006) and ten years of ski patrol experience. He worked with the Yellowstone Club Ski Patrol from 2009 – 2016, and with the Bridger Bowl Ski Patrol from 2016 – 2019. He is a passionate backcountry skier and enjoys all forays into the motorized realm. Dave took over the education program for the Friends of GNFAC in 2016. In addition to his work with local ski patrols and the Friends group, he has developed the Montana State University Snow and Avalanche Workshop in Bozeman, MT, in conjunction with several MSU professors. In his time away from the snow, Dave is a wilderness medicine educator and river guide, having coached whitewater kayaking and taught high school in the United States, Canada, Mexico, Chile, Argentina, Zambia, Uganda, and China. He now runs youth whitewater kayaking programs in Southwest Montana for Wave Train Kayak Team. It is bittersweet for him to transition away from ski patrolling, but he is excited to stretch his thinking about the avalanche problem in new ways and to develop as an avalanche professional.

We are very excited to work with Dave, and certain he will bring innovative ideas to the GNFAC and backcountry avalanche forecasting community.



Irwin Guides Snowcat Skiing

Doug Krause is moving on from his work as a Guide/Forecaster at Valdez Heli-Ski Guides and the Director of Professional Development at the Silverton Avalanche School. He accepted a job as Snow Safety Director for Irwin Guides Snowcat Skiing near Crested Butte, CO. Doug is taking over for long time Snow Safety Director Billy Rankin who has been promoted to Guide Operations and Risk Manager. Doug says he is looking forward to again being a part of a busy snow safety operation, this time with leather couches.

Doug's podcast project, Slide: The Avalanche Podcast, has been hibernating for the last year, but he claims there are clear signs that it may emerge from torpor to greet the first flakes of Autumn. Doug says he is free the last two weeks of April if anyone wants to pay him to go heli-skiing.

REDUCED TO
PROTECTION



ASCENT 30
AVABAG

AVA
BAG



Learn more
about AVABAG
on ortovox.com!

The sensationally **LIGHT** and **COMPACT AVABAG SYSTEM** provides **PROTECTION** – even during the most demanding of activities. This has been achieved through a new welding technology and an innovatively simple venturi unit. A reduced number of parts and a completely closed, robust system make the **AVABAG** light, compact and extremely reliable!



ORTOVOX

American Institute for Avalanche Research and Education New AIARE Executive Director: Vickie Hormuth

A native of Colorado, **Vickie Hormuth** is a lifelong skier who's been recreating in the backcountry and for almost 20 years. Thanks to great mentors, she was an early adaptor of avalanche and climbing education. Vickie's passion for the outdoors lead her to a career in the nonprofit realm spanning a multitude of organizations over the past fifteen years including Outward Bound, the Colorado 14ers Initiative, Environmental Defense Center, The Nonprofit Support Center, and the American Alpine Club (AAC).

Vickie's time with the AAC as the Development Director and later as the Director of Strategic Partnerships allowed her to leverage her passion for building meaningful partnerships between nonprofits and like-minded corporate partners. That work was put on center stage when, under her direction, the AAC hosted the 2019 World Cup Ice Climbing Finals in the heart of downtown Denver which brought together multiple stakeholders, along with a crowd of 25,000, the largest ever to attend a World Cup event internationally.

AIARE is built on an impressive tradition of expertise which Vickie looks to build upon by investing in programs, instructors, and trainers so the organization may continue to be one of the premier educators in the industry. She hopes to make avalanche education courses more accessible than ever by working to ensure that cost isn't a barrier to entry for those seeking to continue their personal and professional development. Vickie looks forward to working with the avalanche community to make avalanche education meaningful, accessible, and impactful.

Vickie holds a B.A in Hydro-geomorphology from the University of Colorado, Boulder and serves on the Executive Committee for the State of Colorado Outdoor Recreation Industry Office. Vickie, her husband Scott and two step-sons split their time between Denver and Crested Butte, CO, and when not skiing, she enjoys climbing, mountain biking and the occasional ultra-marathon trail race.



Photo Andrew Tower



Sean Zimmerman-Wall has moved up to a year-round position at AIARE as the Director of PRO Programs. As part of his duties, Sean will manage the diverse team of Professional Course Instructors, collaborate with industry stakeholders and venue partners, and be responsible for the ongoing development of course curriculum. He will continue working as a part-time patroller at Snowbird and lead guide at Snowbird Backcountry Guides during the boreal winter. He also looks forward to teaching a handful of AIARE recreational avalanche education programs throughout the season. Sean still anticipates working in South America during the austral winter as time allows between the new role and raising two groms in the mountains of Utah.



MAESTRALE XT

POWER BEYOND BOUNDARIES
STRONG. LIGHT. PRECISE.

TO FIND A DEALER NEAR YOU OR TO SEE THE FULL LINE,
PLEASE VISIT WWW.SCARPA.COM

SCARPA ATHLETE
CHRIS DAVENPORT

FRED MARMSATER
RED MOUNTAIN PASS, CO

COURSE UPDATE

American Avalanche Institute

New this winter, AAI has developed a Professional Level 2 Continuing Education course. The Pro 2 continuing education course is designed for industry professionals who have taken a Level 3 course, an AVPro, or have significant professional experience. If you or others in your operation have been curious about what is covered in the Pro 2 that wasn't covered in the Level 3 course, this is the opportunity to check it out.

This 3.5-day course will start where the old Level 3 finished. The course will challenge your observation and forecasting skills and ask you to look at terrain in fine detail. This course focuses on avalanche forecasting for different avalanche problems, terrain mapping, and operational risk management. This course is for continuing education, so there will not be a pass/fail component, nor will there be a certification issued.

The first Professional Level 2 continuing education course will be offered in Park City, UT, January 28-31, 2020.

More information can be found at:
www.americanavalancheinstitute.com/courses/professional-level-2-continuing-education-course/

RANDY ELLIOTT:

- Grew up in Montana
- Worked in road maintenance in Yellowstone, and drove snowplow on Beartooth Pass
- Worked as Bridger volunteer patroller during college days in the early 70s
- Started his long career at Bridger on the trail crew in 1978
- Became mountain manager by 1990 and continued in that job through 2018/19
- Then became general manager for 2004–2018 while continuing as mountain manager and 6 or 7 days per week avalanche guy
- Will continue as avalanche guy...still running excavator and working on power improvements this summer
- Karl's quote from Randy's Kingery citation: "He is so amazingly competent at so many different levels and with so many different skills."
- Great with groomers, dozers, excavator, chainsaw...
- Led the redesign and construction of Bridger's lift system, eventually responsible for opening D-Route and Slushman's avalanche terrain. Major leader in Gallatin County Search and Rescue program.



Two Bridger Guys—Elliott and Richmond—Not Really Retiring

Two old guys at Bridger Bowl will have new titles this winter, but we can't seem to get rid of them altogether. **Randy Elliott**—former general manager, mountain manager, avalanche leader, County SAR leader, and otherwise ace-of-all-trades, has relinquished his titles and will fill in whenever there is a big rescue mission, avalanche day, or empty seat in a groomer. Maybe he will get some time to ski some other areas and spend time with the grandkids. It will be a big change not having the expert guidance he has provided for six or seven days a week over the last 40+ winters. He has set a high bar for the three or four people it will take to replace him.



Doug Richmond has "transitioned" from patrol director to fill-in line patroller, planning to help out as needed and put the "ski" back in ski patrolling. He's looking forward to a shorter work week and to watching others buy the band aids and go to the meetings.

That leaves **Pete Maleski** in charge of the ski patrol to boldly lead us into the future. Pete has been the Snow Safety Director and Assistant Patrol Director for several years and has a full crew of veterans returning. Bridger, like elsewhere, has seen big annual increases in skier visits over the last few seasons. It's a big challenge. You got this Pete.

—Doug Richmond

Northwest Avalanche Center

Dennis D'Amico moves up at the Northwest Avalanche Center (NWAC). After several years of planning, a retirement or two, and a year of targeted operational transition, (detailed in this year's season summary) NWAC is poised to begin a new chapter. Accordingly, NWAC is pleased to announce that Dennis D'Amico is the new Director of Forecasting.

Dennis developed a passion for snow and weather while growing up in Long Island, NY. He attended Cornell University and received a BS from the Atmospheric Science department. After working as a meteorologist for a Canadian TV company, Dennis landed a weather forecasting position with the Seattle NWS. He was hired as an avalanche meteorologist for the Northwest Avalanche Center in 2012 and managed the NWAC mountain weather program during the 2018/2019 season.



NWAC's program includes more than 50 weather stations, mountain weather and avalanche forecasting for the Washington cascades and Mt. Hood, and operational support for WSDOT and Cascadian ski areas. It is a big job. Dennis's personality and experience will suit him well in this challenge, and he is excited to continue the upward trajectory of the USFS forecasting team. Specifically, he plans to pair the strength of the institutional mountain weather program with the newer field-based avalanche forecasting team. Welcome Dennis!

— Simon Trautman

DOUG RICHMOND:

- Started patrolling at Sugar Bowl, CA in the January 1973, moved to Copper Mountain for 2 years in the mid-70s, then to Bridger in 1977
- Two-year stint helping run the small Teton Pass ski area around 1990, then back to Bridger
- Became Snow Safety Director in about 1996, working for Director Fay Johnson—one of the great female pioneers in pro patrolling
- Became patrol director when Fay stepped down in 2010
- Now he is going back to his roots as a line patroller, the best job there is



Training for Backcountry Enthusiasts and Mountain Professionals

Rec Level 1, 2, & Avalanche Rescue Curriculum
Instructor Training Courses
Professional 1 & 2 Courses

avtraining.org

719-221-0762

PETE MALESKI:

- Patrolled at Bridger since ~2000
- Became snow safety director ~2008
- added assistant patrol director title ~2010
- Works year-round for Bridger, doing construction and maintenance during summers

UNDERSTANDING THE PACIFIC NORTHWEST WINTER BACKCOUNTRY TRAVELER

BY JONATHAN CHRIEST & CHERI HIGMAN

Winds whip through crowded parking lots and snow-covered trailheads in the Pacific Northwest, but under a blue tent with the Northwest Avalanche Center's logo resides volunteers with warm smiles, propane powered heaters, steaming cups of coffee, and useful avalanche information. Over the past two winters the Northwest Avalanche Center (NWAC) launched and grew a Trailhead Outreach Project, with a primary goal to reach winter backcountry recreationists where they play and inform them of the forecasting services and education opportunities the center provides to their community. Through this project NWAC was able to launch a sustainable and effective program while gaining a better insight to the community for which we serve.

Sustainable Programming

NWAC's Trailhead Outreach Project's success is driven by its simplicity—folks connecting with folks at popular trailheads that have easy access to avalanche terrain. A legion of volunteers is trained and tasked to set-up tents and tables with outreach information, collect surveys with user information, and to engage with the public. We take special care to ensure that volunteers' communication is positive, systematic, and informative while making the NWAC tent a welcoming place for people to stop by on their way out to slide, ride, walk, and play. Volunteers staffing the tents are put through an evening of training over communication practices following the NWAC Trailhead Outreach Communication Flowchart. Volunteers feel well equipped to field difficult questions and backcountry users receive consistent messaging. Over two winters, 68 volunteers have attended a training. 41 volunteers and 20 NWAC staff and board members have volunteered one or more days under the tent, amassing a total of 649.5 volunteer hours.

Effective Outreach

The most powerful piece of NWAC's Trailhead Outreach Project is our ability to connect with all types of user groups with all variety of experiences. Few, if any, programs exist where you can connect with people pulling the tags off their snowshoes at a parking lot while also chatting with local ski heroes. From December 2017 through March 2019 volunteers hosted 29 Trailhead Outreach events in the PNW all the way from Mt. Baker to Mt. Hood. We connected with 4,767 uphill backcountry travelers, collected 1,597 surveys, and distributed thousands of danger scale information cards, stickers, CLIF bars, and warm cups of coffee.

Trailhead Outreach is an excellent way to introduce unfamiliar backcountry users to the resources that NWAC and other avalanche centers provide. New travelers walk away with some resources to fold into their weekend adventure planning as volunteers present a laminated printout of the day's avalanche forecast, explain the North American Public Avalanche Danger Scale, and promote free avalanche awareness courses. NWAC's Avalanche Specialists and Professional Observers also spend time under our tents, where they share their experiences and answer questions from our community.

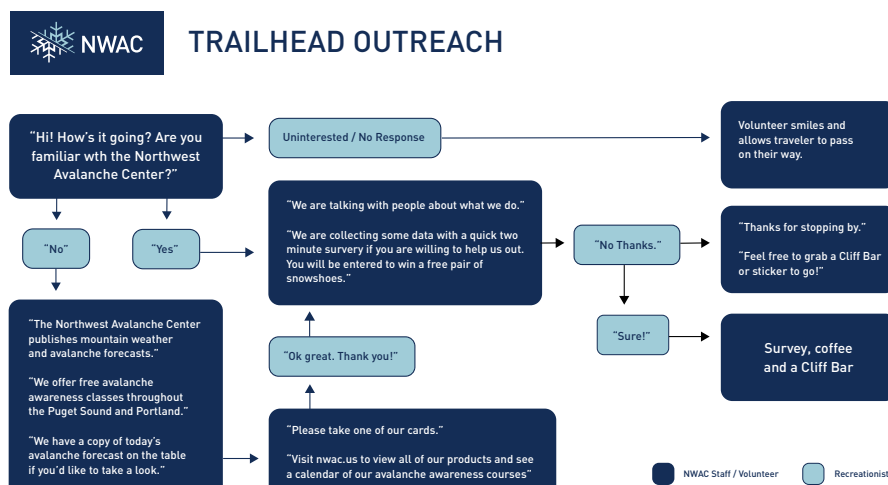
Understanding the PNW Backcountry Traveler

Our secondary objective of the Trailhead Outreach Project is to collect traveler information through surveys designed to gain more insight into the PNW backcountry recreationist. Different from previous studies on backcountry demographics and behavior, avalanche professionals and seasoned backcountry users are not the main targets for our data collection. Instead, we set out to collect a holistic representation of backcountry travelers on any given weekend day. The data collected through the Trailhead Outreach Project so far was captured in 10 events at four trailheads in 2017/18 and 19 events at 12 trailheads in 2018/19. All trailheads have easy access to avalanche terrain and most trailheads receive steady weekend traffic. User groups have been classified as: skiers, snowshoers, snowmobilers, snowshoers, sleds, and climbers.

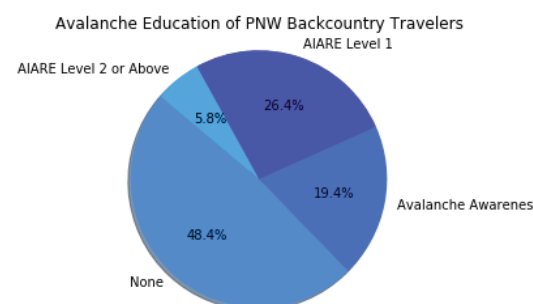
Among all travelers it is important to note—as shown below—that over half of the nearly 1600 surveyed over the two winters had some form of avalanche education. Skiers and splitboarders reported significantly (statistically) higher levels of avalanche education than any other user group. However, fewer than half of all backcountry travelers carry the necessary avalanche safety gear needed to perform a rescue in the event of a burial. While not all travelers surveyed had plans to enter avalanche terrain, avalanche terrain could easily be accessed in a short day-trip from every trailhead at which we conducted the survey.

Surveys are also evaluated to produce a safety index. These indices have turned out to be highly correlated with users' familiarity with NWAC. Individuals familiar with NWAC are more informed regarding these three metrics: avalanche forecast, level of avalanche education, and traveling with avalanche safety equipment. This finding demonstrates the value of the project to promote the Northwest Avalanche Center and the resources it has to offer.

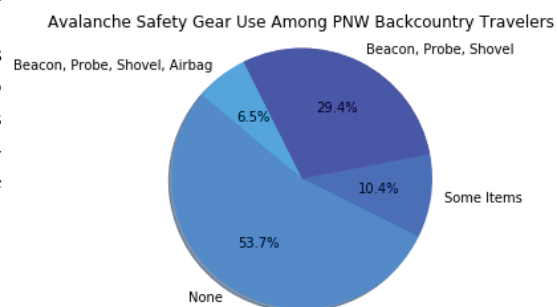
We are enthusiastic about the success of this program and anticipate growing it further next season with the support of our community and volunteers. If you are interested in bringing the Trailhead Outreach Project to your forecast region and have further questions you are encouraged to reach out to the Northwest Avalanche Center at cheri@nwac.us.



NWAC Trailhead Outreach Communication Flowchart.



Level of avalanche education among all users.



Proportions of users carrying avalanche safety equipment.

Jonathan Christ served as NWAC's first Trailhead Outreach Coordinator while he was an undergraduate Atmospheric Sciences student at the University of Washington. He has since migrated further north and enjoys skiing to work at the National Weather Service in Fairbanks, Alaska and is doing Master's research on fire weather at the University of Alaska, Fairbanks.



Cheri Higman has been with the Northwest Avalanche Center since 2018 as their Education and Outreach Manager. She currently works and plays in the mountains near Seattle, Washington.



2019 GALLATIN NATIONAL FOREST AVALANCHE CENTER PROFESSIONAL DEVELOPMENT SEMINAR

BY ANDREW SCHAUER & ALEX MARIENTHAL

The 2019 GNFA Professional Development Seminar featured speakers sharing research and experiences from on the snow, in the lab, at the helm of a chainsaw, and from combat scenarios. The pool of attendees was equally diverse, with a blend of patrollers, forecasters, educators, guides, and researchers. **Dan Kaveney** (American Avalanche Association) kicked the day off with a synopsis of the goings-on at A3, touching on the pro/rec split in avalanche education, multiple research grants and scholarships, and some serious outreach. He also highlighted some short-term goals for A3, including expanding the availability of professional avalanche courses and building on the current research grants and scholarships.

Kevin Hammonds (Montana State University Subzero Research Laboratory) followed, outlining some current research projects in the Subzero Lab. One project aims at developing Lidar tools to look at snow structure in the lab and deploying the technology in the field, with the goal of providing forecasters with a tool to collect real-time snow stability data. Another project investigates the effects of chemical impurities on ice strength and raises some interesting questions relating air quality during precipitation events to snow strength. A third project is motivated by observations he made while ice climbing, exploring the relationship between changes in temperature and ice strength. Kevin passed the mic to **Chris Borstad**, a new professor in the MSU Engineering department, who shared some of his work using thin-blade hardness gauges to measure bond strength. He identified changes in stress concentrations related to slab stiffness, and proposed using a ratio of slab-to-weak layer blade hardness as a means to improve false unstable rates with ECT tests. He was followed by **Chris Donohue**, a Ph.D. student in the MSU Subzero Lab. Chris discussed his work building wind slabs in a wind tunnel, then using micro-computed tomography to investigate microstructural properties of wind slabs. He is currently working on measuring temperature gradients around the lab-made wind slabs at an extremely fine scale (100 μm spacing), in order to see how temperature gradients are affected by changes in snow microstructure.

Ron Simenhois (CAIC) recounted the March 2019 avalanche cycle in Colorado. Ron shared some fantastic photos and videos of the historic cycle, and described the challenges they faced trying to mitigate avalanche hazard while maintaining transportation corridors across the state. Ron shared a few takeaway lessons from his experience cautioning that we should assume something will always go wrong while dealing with an unusual event. He also stressed the importance of using a consistent daily routine to minimize decision fatigue from making trivial decisions like what to eat or what to wear, in order to focus on major decisions during difficult events.


Erich Pietzsch (USGS/Ph.D. candidate in the MSU Dept. of Earth Sciences Snow and Avalanche Lab) shared his current research in two different arenas. One project uses dendrochronology to look at the historic frequency of large avalanche cycles in Northwest Montana and understand the climate variables associated with major cycles. He noticed that major avalanche seasons were commonly associated with increased annual precipitation, decreased winter temperatures, and tended to occur during negative phases of both the El Niño/Southern Oscillation (i.e. La Niña seasons) and the Pacific Decadal Oscillation. His second project investigated avalanche fatality demographics and identified the group with the highest fatality rate was age 30–39. He suggested recreationists from this demographic may not have taken an avalanche course in a very long time, and posed some thought-provoking questions about how limited free time and hindsight bias play a role in decision-making as we age.

Matt Welborn, a retired helicopter pilot from a special mission unit in the U.S. Army, shared his insight into stressful thinking. He described chemical changes in our brain during stressful situations, and provided some tools to act efficiently while under stress. Matt described our natural ‘flight, fight, or freeze’ response while in a dangerous or life-threatening position, and highlighted the importance of relying on planning and training to avoid freezing in a critical situation. He also emphasized the importance of situational awareness in making quick decisions, and stressed the need to recognize a hazard and act quickly to mitigate the problem.

Pete Maleski (Bridger Bowl Ski Patrol) discussed his approach to forecasting downslope winds at Bridger Bowl, which are difficult to predict and can have important implications on snow stability as a result of unusual loading patterns. Pete described a tendency to observe downslope winds as a result of wind shear when northerly winds at upper levels meet westerly ridge-top winds. He demonstrated the utility of atmospheric cross section charts to forecast for downslope events.

Zach Guy (Flathead Avalanche Center) described the difficulties in predicting a wet slab cycle in late March 2019 and shared some lessons learned. He described an unusually cool snowpack prior to the cycle, which experienced rapid warming after observing temperatures that were much warmer than what was forecasted. He also described difficulties in identifying exact timing of events, which made it challenging to adjust danger ratings. Zach described key thresholds that may be used to predict similar events, including the first day of snow wetting, the first day with daytime temps above 50°F, and the third consecutive night without a refreeze.

Drew Pogge (Big Sky Backcountry Guides) wrapped up the day discussing risk management and emergency response for self-guided backcountry yurt users. Drew addressed factors that increase the risk to self-guided groups, including large group sizes, mixed ability levels within the group, and the use of drugs and alcohol in the backcountry. He noted the importance of communications capabilities and rapid extraction as two critical factors in the case of an emergency. Drew discussed some changes that can be made to reduce the risk to self-guided users including requiring a higher level of avalanche education, satellite communications, and a terrain and snowpack orientation meeting prior to the backcountry trip.

Videos of all the speakers at this workshop, and all past GNFA Pro Development workshops can be viewed on the GNFA Youtube channel (AvalancheGuys). 



CALTOPO
BACKCOUNTRY MAPPING EVOLVED

Powerful trip planning tools and advanced maps now available at your fingertips any time, anywhere.

Plan your next adventure at caltopo.com today!

Mobile app is now available for download.



TRANSPORTATION AVALANCHE RESEARCH POOL

BY JOHN FITZGERALD

The **Transportation Avalanche Research Pooled Fund (TARP)** is comprised of member organizations aimed at funding avalanche research related to transportation issues. We want to let the greater avalanche community and in particular researchers know that we are always open to new research ideas/proposals. Here are some details about the group.

TARP supporters share a common vision of collaborative avalanche research efforts and deployment of technologies and methods to better serve the traveling public through safer and more efficient avalanche operations.

The mission of the Transportation Avalanche Research Pool is to enhance cooperative inter-agency research that improves the safety and effectiveness of avalanche safety operations, and to facilitate communication between transportation agencies that encounter avalanche hazards.

The goals of TARP define areas of potential benefit pursued by the group. TARP's specific objectives directly address activities that support progress toward realization of the goals. The below program goals are defined for the purpose of evaluating the usefulness of research projects. In addition to meeting one or more of the below goals, proposed projects should also be specific in their projected outcomes and should produce results that are able to be implemented in practice within avalanche programs. TARP's goals and subsequent objectives are:

- To enhance collaboration in avalanche research.
- To identify common research and deployment needs within the group and to pursue resulting technical activities.
- To provide a means of sharing research and methods between group members.
- To improve information gathering and analysis techniques relating to avalanche hazards and risk.
- To explore and evaluate currently available and emerging technologies that could enhance TARP members' avalanche program efforts.
- To apply the information towards improving avalanche operations.
- To improve the safety of avalanche mitigation operations to both avalanche workers and the public.
- To define universal measures of the effectiveness of avalanche mitigation operations.
- To explore new avalanche mitigation methods and related technologies.
- To continually evaluate new technologies to gauge applicability to avalanche programs.
- To encourage group members to adapt new, effective techniques of avalanche control to set precedents for the rest of the country.



Cleaning up a 25 foot tall pile at the Cow of The Woods path on April 9, 2019, triggered by O'Bell X.
Photo John Fitzgerald

Transportation Avalanche Research Pool member agencies are as follows:

- Alaska Department of Transportation
- Colorado Department of Transportation
- California Department of Transportation
- Utah Department of Transportation
- Washington Department of Transportation
- Wyoming Department of Transportation
- Alaska Railroad
- New Zealand Transportation Agency
- British Columbia Ministry of Transportation and Infrastructure

TARP is also working with several research organizations already teamed with member agencies. These currently include:

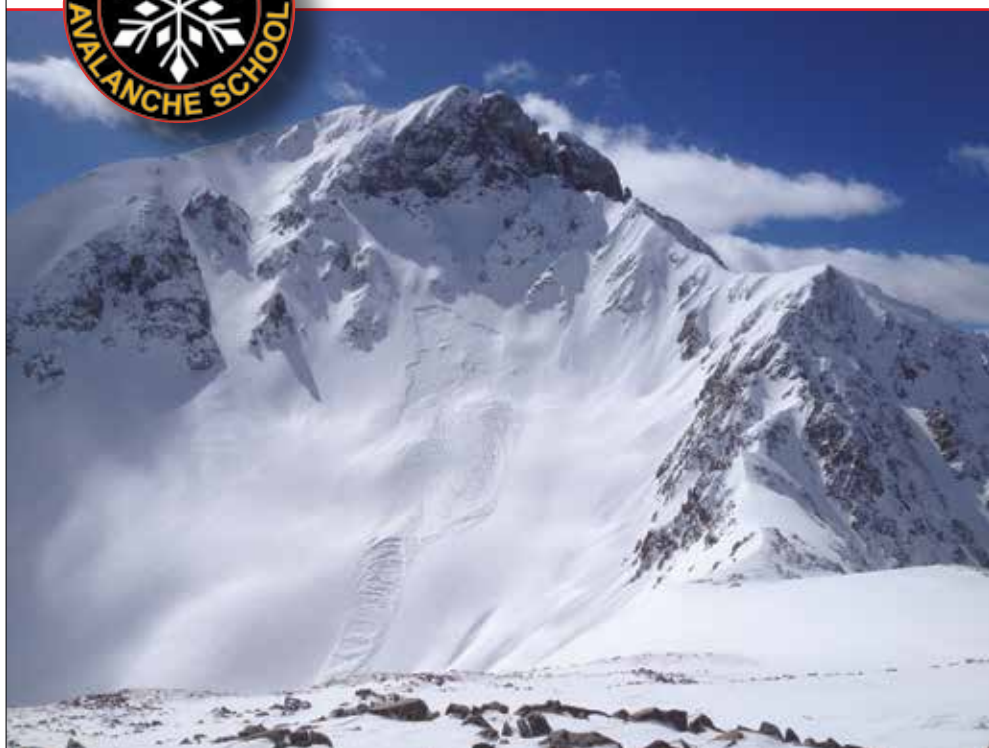
- University of Colorado Boulder
- Colorado School of Mines
- Boise State University
- Montana State University

Should you or your organization be interested in contacting the TARP about research ideas, please contact John Fitzgerald at: john.fitzgerald@wyo.gov

John Fitzgerald currently heads up the avalanche program for WYDOT, and really enjoys being ahead of the curve when it comes to shooting.



Where the Snow Pros Go



Comprehensive avalanche training in the heart of avalanche country. Professional, rescue, recreational, industry and tactical.

www.avyschool.org
Silverton, Colorado
970-387-8329

U.S. MOTORIZED AVALANCHE FATALITIES 2018/19

BY MIKE DUFFY

It was an interesting year for snowmobile avalanche fatalities in the U.S. It's as if we stepped back 20+ years to when snowmobile fatalities involved the lack of avalanche rescue gear. The fatalities last year had an inordinate number of unprepared riders, which is not what we expected to see with record number of riders attending advanced classes and buying gear. The opportunities exist for motorized-specific courses. Like other user groups, avalanche knowledge and preparedness varies tremendously. Many riders have chosen not to be educated or properly equipped.

Total U.S. Avalanche fatalities: 25

- U.S. Snowbike fatalities: 0
- U.S. Snowmobile avalanche fatalities: 8

Breakdown of U.S. Snowmobile Avalanche Fatalities 2018/19:

- 32 % of the total US avalanche fatalities were snowmobilers.
- Snowmobile fatalities by state: UT-3, WY-3, MT-1, ID-1.
- All victims were single complete burials.
- 63 % of the snowmobilers killed did not have a transceiver.
- All riding partners were not fully equipped with transceiver, shovel and probe in 63% of the accidents.
- 63% of the victims were dug out by people outside the riding group,
- Digging time to reach the victim varied from six minutes to the next day. Majority were not timely.
- Midwest riders accounted for 25% of the snowmobile fatalities, while western riders were 75%.
- 100% of the accidents were triggered by riders in the group.
- 100% of the fatal avalanches failed on a persistent weak layer.
- 63% of the accidents had riders in the runout zone.
- Multiple people on the slope only occurred in one fatality.
- 38% of the accidents involved a potential searcher getting caught in the avalanche which delayed the rescue.
- 25% of the victims had deployed an airbag.
- Almost, if not all, of the riders lacked advanced avalanche training.

There's room for improvement with many riding groups. It appears that most victims died from asphyxiation, but results are inconclusive without coroner's reports. These snowmobile statistics are a definite contrast to winter 17-18, when 18% of the victims did not have transceivers and 50% died from trauma. ■

Mike Duffy is Director and Lead Instructor at Avalanche1. He travels annually across the country presenting sled-specific avalanche safety training at snowmobile dealer and club locations.

NEW EL PROFESIONAL SNOW SAW



BY MATT PRIMOMO

Over the seasons, I've had the privilege of working with many avalanche professionals, and have taught avalanche courses to hundreds of winter enthusiasts and workers. In the process, I've performed thousands of snowpack tests and have used most snow saws that are readily available. Often I find that other saws are too heavy, too flimsy, not the right shape or size, don't come with a good sheath, are too expensive, etc. The reason I designed a saw was because I wanted a better tool to use on a daily basis. Friends and colleagues caught word that I was making a saw and expressed interest, so it seemed logical to make a batch to recover some startup fees. The saw I created (that I'm calling El Profesional) is one of the lighter snow saws out there, weighing in at ~4oz with the rubberized tooth protector. Craftsmanship in snow profiles is something I continuously work on, and clean test columns aid in interpreting the results of fracture character. A long and straight blunt edged, sturdy snow saw with teeth made to remove snow in-line and bust through crusts will help achieve that.

Additionally, Gauthier, Jamieson, and others (2007) identify a saw thickness of 2mm as the tool used during the research and development of the Propagation Saw Test. Many other snow saws range quite a bit thinner or thicker than that spec. Ross and Jamieson (2012) specifically evaluated the difference between a thick (~2mm), and thin (~1mm) saw, and find that cut lengths tend to be significantly longer with a thin saw than with a thick one. Because of this, and other similar findings (McClung, 2011), I believe it is best to stick to a sawblade of ~2mm in thickness as standard practice. A millimeter or two may not seem like much, but when we are breaking bonds at the scale of grains, then evaluating the results at the centimeter scale, the little things matter.

A few other key features include a 30cm mark, and a bottle opener for good measure. The snowpack can be complex, so it's all about helping us to perform standardized tests so that we can better wrap our heads around our results. If you plan to slice up lots of snow, don't want to carry extra weight, and want to support a fellow avy pro with a grassroots, locally made and hand sharpened product that looks good, check out the website! Thanks for your support, and happy snow sawing! ■



Gauthier, D., 2007. *A Practical Field Test for Propagation and Arrest in Weak Snowpack Layers in Relation to Slab Avalanche Release*. Ph.D. thesis, 302 pp., Univ. of Calgary, Alberta, Canada.

McClung, D.M., 2011. *The Critical Size of Macroscopic Imperfections in Dry Snow Slab Avalanche Initiation*. *Journal of Geophysical Research*, Vol. 166, F03003.

Ross, Cameron K.H., and Jamieson, B., 2012. *Instruments and Methods- The Propagation Saw Test: Slope Scale Validation and Alternative Test Methods*. *Journal of Glaciology*, Vol. 58, No. 208, 2012.

COLORADO MOUNTAIN COLLEGE

Avalanche Science

TWO-YEAR INTENSIVE PROGRAM

475 HOURS OF STUDY
A3 PRO CERTIFICATION

COURSES INCLUDE:

- ✦ METEOROLOGY
- ✦ FORECASTING
- ✦ INTERNSHIPS
- ✦ RISK MANAGEMENT
- ✦ MITIGATION

Learn more at
▶ Coloradomtn.edu/avalanche-science

ARE WE TEACHING CONFIDENCE OVER COMPETENCE IN AVALANCHE EDUCATION?

BY DAVE RICHARDS

When I first started to dwell on this piece of rambling thought, I had just finished reading an article in TAR 37.1 in which two skiers told a story of their experience with an avalanche while doing a photo shoot on Mount Bachelor. The article is interesting in that it discusses some potential lessons from the event. However, as you near the end of the piece you are confronted with take-home points in yellow highlight. None of these take-home points are about mistakes or lessons learned! All the points are about what they did right. Why? They unintentionally triggered an avalanche. Something went wrong, where is the story about that in yellow highlighter? This is a common theme. Did they learn anything?

As I read stories like this from newer backcountry users, I often hear tales of greatness. How they read the forecast, checked the beacons, dug ONE hole and ripped. They are then surprised when they trigger an avalanche, nonetheless they write up the event and usually the emphasis is on what they did right. Again, no, you *unintentionally* triggered a backcountry avalanche! Some would say that the only people who should ever trigger an avalanche are professional avalanche workers. Well, yes probably. It is the job of a ski patroller to be an avalanche hunter. A backcountry skier must be an avalanche avoider at all costs. This is a hard thing to express to the backcountry user who just watched a movie showing their heroes skiing away from an Alaskan avalanche unscathed.

It is certain that the number of backcountry users is growing at an enormous rate. And admittedly but perhaps more interestingly the number of FATALITIES has not matched that growth. However, we are seeing an enormous number of close calls and partner rescues and these numbers do seem to be growing. I would say that, although survival should be celebrated, there's a set of important lessons that need to be brought home.

These close calls indicate that the industry has done an excellent job of training janitors who are able to clean up the mess, but not preparing people to avoid making messes in the first place. Eventually the accident gets messy enough that no beacon skills can clean it up.

THE LEARNING EXPERIENCE:

Current avalanche training is excellent, but we have the entry level wrong. We are creating skiers who think that if you have the gear and know how to use it then you are qualified to just head on out. I would say that they are not. A beacon is just a worthless computer strapped to your chest when you are beaten to death by the trees. The trauma and seriousness of avalanches is not properly conveyed in avalanche education.

When first researching this, I had a long email discussion with my friend Sarah Carpenter, owner of and educator for the American Avalanche Institute. The first thing that Sarah sent me was the curriculum for the level one recreation and pro courses. I was immediately struck by one thing. Al-

though it is true that the first lesson in every course is beacon skills and often a beacon test, against my suspicions there was substantially more emphasis on terrain and travel than there was on rescue. Amazing! This is what I have always wanted to see. I have ranted many times that we were teaching the skills backwards. It should always be to stay out of the avalanche first and rescue as a last resort second. Hard to do, I know, but critical so as not to teach a false sense of safety.

This left me with a conundrum; if Sarah was teaching the right information in the right sequence then why are people making the wrong decisions? Reality...I understand that when in the mountains it is impossible to accurately read clues all the time. There is no question that avalanche events can and will happen.

The question then became, why are people proudly telling us about their avalanche education at the same time as they are telling us about getting caught in avalanches? Are we teaching them the wrong thing? In fact, research has shown a correlated risk exposure with the attainment of avalanche training (McCammon, 2000, 2004).

ARE WE INADVERTENTLY TEACHING CONFIDENCE OVER COMPETENCE?

One thing that I think is flawed in our avalanche education is that we aren't teaching young people the basic human skill of reflecting on their experiences. Being a mentor is not just teaching snow and weather, it is also teaching more basic human behaviors such as reflection and humility. These are traits that are becoming less common in the era of social media and instant gratification. In the modern era I've encountered a different mentality which says that surviving a high-risk event is cool. In social media, scary stories make for more *likes* and more *glad you're ok* comments. Praises and platitudes make it harder to look back and really analyze the event, examining where we went wrong and learning to avoid that same pattern or sequence in the future. We must teach people to spend as much time analyzing what went wrong as we do what went right. It is only through this that we can improve in the future. This is the very basis of learning, tomorrow's forecast must include the lessons from today's experiences.

Does the level one student need to know avalanche mechanics and the nitty gritty of snow metamorphism? My feeling is that the answer is no. This level of backcountry user only truly needs one skill: to be observant. If you keep your eyes wide, the mountains will frequently tell you all you need to know. In fact, evidence shows that the student of basic avalanche education gains a level of confidence, but at the same time they report a breakdown between the ability to grasp information and the ability to transform that information into actionable knowledge (Balent et. al. 2018).

TRANSLATING THEORY TO ACTION

Often, we see people ignoring a vast amount of

DISCLAIMER:

I am not a formal avalanche educator. I have over the years taken the classes, but most of what I have learned is from working as a ski patroller under some excellent mentors, and of course from lessons in poor judgment (both mine and others').

Now as the director of the avalanche program at Alta Ski Area I find myself in the position of teaching up-and-coming avalanche workers. I also find myself frequently looking back on my experiences picking up the pieces from avalanche accidents. When I do this I constantly wonder: what can we learn? Plenty.

information and operating instead on just one tiny bit while rushing out the door to beat the hoards. Every morning you give them what they need to know. How do we make sure they are getting it all? How do we teach them to apply the data available to them? How can we help people to become responsible mountain users as opposed to relying on the wisdom of the "all-knowing" forecast center? We constantly throw around the term "Expert Halo," this may be the most glaring example of that heuristic trap. There is much more to an avalanche forecast than the colors on the hazard rose. People must read between the lines and actually grasp the information which is being presented to them.

Since it seems that we may be missing something in avalanche education, perhaps we should dumb it down to the simplest form. We need to take our recreational user education back down to the basics. In my experience with forecasting and in discussions with other forecasters much more experienced than myself, it seems that the more one sees and learns, the more they simplify their thought processes. As one of my mentors, Titus Case, brought to my attention, we need to focus on the low entropy data spaces that Ed LaChapelle addressed so eloquently in his 1980 paper *The Fundamental Process in Conventional Avalanche Forecasting* (*Journal of Glaciology*, vol. 26, no. 94, 1980). In information theory, **entropy** is a measure of the uncertainty associated with a random variable. Therefore, the concept of thinking in a low entropy data space is that of working with known variables or in less uncertain spaces. What DO I know?

When needing to acquire knowledge about a new situation, an experienced forecaster immediately starts asking questions in low entropy data spaces. The inexperienced person often attacks complex relations of snow and weather and ends up awash in a sea of information. The key first question does not deal with last week's range of snow cover temperature gradients or yesterday's sequence of freeze-thaw crust formations, but simply asks "Has an avalanche fallen recently?" (LaChapelle 1980)

Why are people proudly telling us about their avalanche education at the same time as they are telling us about getting caught in avalanches? Are we teaching them the wrong thing?

In truth you don't need to dig a pit once you know the basic stratigraphy of the snowpack. And this structure is information that the lay user can easily glean from their local avalanche center. Once armed with this knowledge a quick hand shear or simple step off the skin track often tells you much of what you need to know. Then by simply looking around for those other obvious signs such as recent avalanches one can most times complete the puzzle.

THE STUDENT

To be clear, I am not attacking students of the formalized avalanche education process. All of us who go to the mountains are students. I believe that the onus is on all of us to be constantly learning from the mountains and analyzing our experiences of both success and perhaps more importantly failure. The student most often simply doesn't know what to look for.

The problem is not with the incompetent. The incompetent don't know and as a result often don't go just on the basic knowledge that they glean from an avalanche forecast.

It is instead those people whom we have begun to teach, the people who have proudly completed their first avalanche class, that are most dangerous. We may have armed them with a confidence in their knowledge that far outweighs their ability to apply the skills which they have learned. They have just enough knowledge to kill themselves.

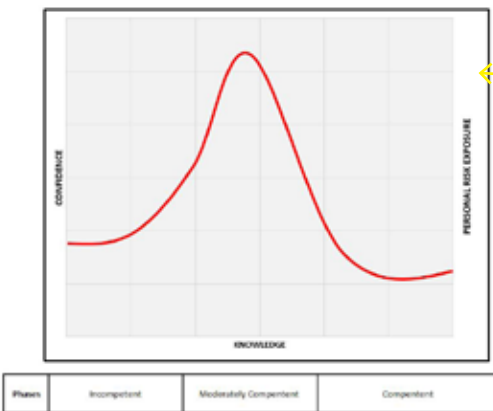
These are the people who Bruce Kay describes right off the bat in his book *Autonomy, Mastery and Purpose in the Avalanche Patch* when he discusses the Dunning-Kruger effect. This study from David Dunning and Justin Kruger from the Cornell University Department of Psychology found that there are three types of decision-makers (*Advances in Experimental Social Psychology*, vol. 44, 2011.) that we can apply to the students of avalanche training.

1. The "truly incompetent" may tend to overestimate their knowledge and skill, but luckily for them these people also frequently recognize that they don't really know anything.
2. The "moderately competent" who will tend to overestimate their knowledge, skill and ability resulting in over confidence. These are the people that Kay describes as suffering from "level one disease." This description couldn't be more accurate.
3. The "most competent" will tend to underestimate their skill, knowledge and ability leading to less confidence than justified. Unknowingly through their humility and lack of confidence which comes from a lifetime of developing experiential expertise these people make conservative decisions.

I think of these people as being dangerous simply because they don't know what they don't know. Yet unfortunately, they think they do.

In my mind these are the long-time avalanche professionals. They still don't know what they don't know, but luckily most at least know that.

These users and decision makers are depicted in **this graph**. (Because really, what piece of bad writing doesn't need a graph?)



DeltaLancer Avalauncher Ammunition

Designed & Developed by Delta K EES Ltd. in the UK
Cooperatively Distributed by Avalanche Control Logistics LLC and
Accurate Energetic Systems LLC In the USA



Key Design Characteristics:

- Safe replacement of Slip-pin ammunition variants.
- Turbine controlled safe arming mechanism.
- Pentolite or enhanced RDX based loading options.
- Low inertial loading of blasting cap to improve safety.
- RECCO reflector cast into main filling.
- Advanced aerodynamic profile.
- Inert and powder marker loads for ranging and/or training.
- Future proof design supports on-going product optimisation programme.



ACL - Dan Dobrowolski - dan@avconlog.com Cell: 434-960-0558

Although this graph is simply a representation of my thought, it seems to be awfully accurate for the situation which we are currently discussing. Of note are the phases of competence listed at bottom. The further one progresses toward competence or expertise, the less they think they know. It is in the center, where the individual is in the zone of the “moderately competent” where they become overly confident, and as a result increase their exposure. This is where bad things happen. These are my overly confident users who are not accurately analyzing either what they have been taught or what they could have learned.

A highly valid learning environment (Kahneman and Klein, *American Psychologist*, vol. 64, no. 6, 2009) is available in avalanche events. Kahneman and Klein say that two conditions are necessary for the development of skill: high-validity environments and an adequate opportunity to learn them. When you trigger an avalanche, either intentionally or not, you are being handed highly valid information, this is direct feedback as to the accuracy of your snow assessment and decision-making: what many people call bulls-eye information. Here is an opportunity for a learning experience through which expertise is eventually developed, as long as the experience is properly debriefed or analyzed for its lessons.

Meanwhile, when a slope is skied but there is no avalanche, this does not qualify as a valid environment. This information is inconclusive. Yes, you may have been right about the snow stability for sure, but you may also have been lucky. Nothing happened so you’ll never know. It is in these learning experiences that much can be learned. As opposed to writing a tale of victory, in a close call we must write a tale of defeat and an analysis of what can be learned.

Based on my observations I believe that our “moderately competent” skier, the one with “level one disease,” is understanding and analyzing these learning opportunities in reverse. They are taking more information from the non-event than from the close call.

THE TEACHER

So, where does this whole thing leave us? I feel as much like a parent as a mentor or teacher in the avalanche industry. The only problem is I’m not a parent, I have no desire to be a parent nor do I have any experience in this realm. Between my parents and mentorship over the years from other forecasters such as Titus Case and Liam Fitzgerald, humility was one of the most valuable lessons I learned in the avalanche world. The other lesson learned was the most basic skill of simply being observant. We can’t outthink the avalanche and will never completely control the avalanche danger. I also learned the importance of taking responsibility for my actions. The rest of the equation must come from lessons learned, whether those lessons are the brutal truths of losing friends or they stem from close calls due to poor judgment.

It is time for us to stop training avalanche safety and start teaching. Along with beacon, shovel, probe, we must add brain. Perhaps it is about parenting—teaching to avoid the fight at all costs instead of how to bandage after we get our asses kicked. ●



Snowbird’s Eric Murakami investigates a backcountry avalanche event in the Wasatch. It’s really important to ask what happened and then work on how to prevent it in the future.
Photo Dave Richards

LIVE.SKI.REPEAT.

THE GUIDE BT BEACON

With a massive 60m circular range, mark and scan function for multiple burials, and an auto antenna switch that automatically adjusts to send the best signal, the Black Diamond Guide BT beacon is the industry-standard, professional-grade avalanche beacon with Bluetooth capabilities.

BLACKDIAMONDEQUIPMENT.COM



HOW RISKY IS SKI CUTTING BY AVALANCHE PRACTITIONERS?

BY BRUCE JAMIESON, KARL BIRKELAND, MARK VESELY, ILYA STORM, & JOHN STIMBERIS

ABSTRACT

In avalanche operations, ski cutting involves a single avalanche practitioner attempting to trigger a snow avalanche by skiing across the upper part of a slope. There are two types of ski cutting: test skiing to determine if the snow is unstable and mitigation to remove unstable snow before the avalanches get bigger or before less skilled people (e.g. clients) get to the specific slopes. To address the wide differences in the perceived risk of injury during ski cutting, we conducted a quantitative survey that helped avalanche practitioners estimate the number of ski cuts over many winters and asked them to recall their near misses and three classes of injuries. Over 150 practitioners completed the survey with a combined career total of 1.5 million ski cuts. From the responses, we calculated various results. The median number of ski cuts per respondent was 300 per winter. The rate of triggering a size D1 to 1.5, D2 to 2.5 and D3+ avalanche was 300, 4 and 0.1 per thousand ski cuts, respectively, indicating that smaller avalanches are triggered much more often than larger ones. The rate of being caught in a size D1 to 1.5, D2 to 2.5 and D3+ per thousand triggered avalanches was 7, 25 and 80, respectively, indicating that the probability of being caught increases with the size of an avalanche triggered during ski cutting. When the survey results are scaled to a million ski cuts, about 23 resulted in light duty, 7 resulted in missed work and 3 resulted in career ending injuries. Practitioners at lift-based ski areas (ski patrollers) had lower risk for the same number of ski cuts than guides for helicopter and snowcat skiing.

INTRODUCTION

A ski cut is an attempt to trigger an avalanche by starting in a low risk location, skiing across all or part of an avalanche start zone to a location with lower risk. This study does not distinguish between slope cutting on skis or a snowboard.

Ski cutting is a basic skill that remains widely used by avalanche practitioners. For example, one of the competencies in the Canadian Avalanche Association's 2015 draft competency profile is "artificial triggering (excluding the use of explosives)". Some winter recreationists also ski cut slopes, but the survey and this paper pertain exclusively to ski cutting by avalanche practitioners while at work.

There are two types of ski cutting: test skiing to determine if the snow is unstable and mitigation to remove unstable snow before the avalanches get bigger or before less skilled people get to the specific slopes. Looking at avalanche operations across North America, the number of slopes ski cut for mitigation in a winter far exceeds the number of slopes test skied.

Advantages of ski cutting:

- Provides high strength and high weight evidence of snow instability, which is key information for avalanche forecasting operations. Many slopes ski cut but not triggered is an indicator of stability and can be of high weight if many representative slopes are ski cut.
- Removes unstable snow before the avalanches get bigger during storms or before less skilled people (e.g. clients) get to the slopes.
- More effective for triggering for loose wet snow avalanches than explosives.
- Faster than explosives when dealing with many start zones if only small avalanches are expected.
- Can be efficiently used in combination with explosive mitigation, i.e. ski cutting for the smaller or less severe slopes and explosives for the more severe slopes. Also, practitioners can "clean up" (i.e. remove) small pockets of unstable snow that remain after explosive mitigation.
- Cost effective when there are many start zones and/or practitioners with related skills (e.g. guiding, first aid, skiing) who are consistently on site.
- Practitioners can learn about the spatial

Discussions between "avoiders" (who perceive the risk to be unacceptably high) and "engagers" (who perceive the risk to be low and acceptable) are frequently unsatisfactory.

characteristics of unstable snow, i.e. trigger points which is relevant to placing explosives, as well as snowpack variations over terrain that are relevant to avalanche release and route selection. Practitioners can also learn about the transient nature of snow instability, including storm slabs. This knowledge about the spatial and temporal characteristics of unstable snow is difficult to learn in the classroom.

Disadvantages of ski cutting:

- People can be injured and potentially killed while ski cutting.
- For operations with many small slopes and a few large slopes (or slopes with terrain traps), the efficiency of ski cutting can deter the use of lower risk methods of avalanche mitigation, such as explosives, on the larger or more serious slopes.
- The distinction between a low risk ski cut and a high risk ski cut can be difficult to consistently determine in advance. For example, on a day when ski cutting many shallow slabs resulting in D1 avalanches, practitioners infrequently trigger slabs that are deeper than expected, resulting in larger avalanches.
- A small number of ski cuts that do not trigger avalanches can be misleading, i.e. they do not provide high weight evidence of stability, especially for deeper weak layers.

The perception of the risk of injury and death during ski cutting varies widely. Discussions between "avoiders" (who perceive the risk to be unacceptably high) and "engagers" (who perceive the risk to be low and acceptable) are frequently unsatisfactory.

The objectives of this study are:

- To quantitatively estimate the rate of near misses and injuries from ski cutting and hence inform policies, practices, decisions and discussions about ski cutting
- To quantitatively estimate the rate of triggering and being caught while ski cutting

by avalanche size (D-scale; McClung and Schaerer, 2006)

The survey and this paper do not identify practices to minimize risk while ski cutting. However, Stimberis (2008, 2018) and Wilbour (1986) identify low risk practices for ski cutting. Also, Richmond (1994) and Vesely (2014) identify patterns in near misses and injurious ski cuts.

A brief history of ski cutting

In this section, we review ski cutting as mentioned in selected publications, especially older publications. Seligman (1936, p. 483) mentioned triggering unstable snow (mitigation) by sending a belayed skier onto the slope. In a chapter of the NRC/BCIT manual for Canadian avalanche practitioners, Wilson (1974) outlines test skiing as well as "protective skiing" (i.e. mitigation) before more unstable snow accumulates or hours before naturals are expected. Perla and Martinelli (1976, p. 104) noted that unbelayed test skiing should be on small slopes only, implying belayed test skiing is an option for bigger slopes. LaChapelle (1970) outlined test skiing on short slopes. The Canadian Avalanche Association's (CAA) 1985 curriculum document for courses for advanced recreationists specifies that the instructor "demonstrate test skiing" and twice mentions that recreationists should consider the results of test skiing when assessing the avalanche hazard. When describing test skiing for winter recreationists, Daffern (1992, p. 144) recommends caution on larger slopes. Hence, ski cutting (test skiing and mitigation) has a long history for avalanche practitioners and winter recreationists.

Fatalities during ski cutting in the United States and Canada

Since 1980, there have been three fatalities associated with ski cutting in the U.S. according to records maintained by the Colorado Avalanche Information Center. The first fatality was a person who ski cut a large avalanche after explosives had been thrown on the slope in 1983. This was in an out-of-bounds area that was not normally skied

SECTOR	NO. OF CAREER PHASES	NO. OF SKI CUTS	NO. OF SKI CUTS PER WINTER PER RESPONDENT			
			Q1	Q2	Q3	Average
Ski areas	128	1,081,962	199	400	810	661
Mechanized ski guiding	45	323,905	120	300	700	476
Non-mechanized ski guiding	15	11,189	63	90	158	108
Highways & resource industry	9	59,140	60	78	660	428
Backcountry forecasting	11	14,245	40	140	233	191
Other	3	5,380	40	60	130	93
All sectors	211	1,495,821	120	300	700	539

Table 1: Number of ski cuts per winter per respondent and total by sector.

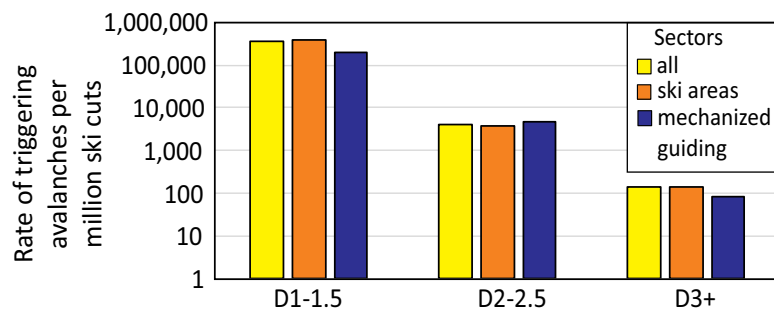


Figure 1: Rate of triggered avalanches per million ski cuts by avalanche size and sector. The log scale for the left axis allows the triggering rate for D2 to 2.5 to be distinguished from the rate for size D3+ avalanches.

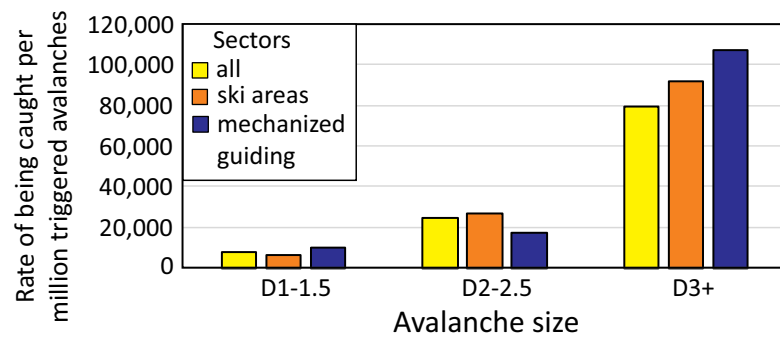


Figure 2: Rate of being caught per million avalanches triggered while ski cutting for three size classes of avalanches (D1-1.5, D2-2.5, D3+). The results are shown for ski areas, for mechanized ski guiding, and for all sectors.

SECTOR	AVALANCHE SIZE		
	D1-1.5	D2-2.5	D3+
All	345,056	4,038	143
Ski areas	394,442	3,760	141
Mechanized guiding	196,212	4,677	86

Table 2: Triggering rate per million ski cuts by avalanche size.

SECTOR	NO. OF CAREER PHASES	NO. OF SKI CUTS	NUMBER OF NEAR MISSES AND INJURIES			
			Near miss	Light duty	Missed work	End career phase
Ski areas	128	1,081,962	444	19	3	1
Mechanized ski guiding	45	323,905	106	12	4	3

Table 3: Summary of survey responses including near misses and injuries by sector.

or mitigated for avalanche hazard, and a wide avalanche released in depth hoar near the ground. The second fatality was in 1994 and involved a patroller ski cutting a slope at the end of their control route when they had run out of explosives. The third ski cutting fatality was in 2016 and involved a cat skiing guide who was ski cutting some terrain before opening it for his guests.

Also since 1980 in the U.S., there have been nine avalanche fatalities in seven incidents during explosive mitigation of avalanches. In each one of these cases the avalanche mitigation team threw an explosive downhill of their position, but the resultant avalanche propagated upslope, capturing the practitioner(s). While these accidents are not a completely valid comparison with ski cutting since explosives are preferred over ski cutting for larger slopes and deeper slabs, these fatalities demonstrate that explosive control is not a risk free alternative to ski cutting.

According to records kept by the Canadian Avalanche Association and more recently by Avalanche Canada, there has only been one avalanche fatality during ski cutting in Canada. In this 1994 incident, the rescue of the buried practitioner was delayed because he was not wearing an avalanche transceiver (Jamieson and Geldsetzer, 1996, p. 94-95).

This article was shortened for *The Avalanche Review*. The complete version of this article is available at https://avalanche.org/wp-content/uploads/2019/08/19_Jamieson_et_al_SkiCutRisk.pdf.

THE SURVEY

The links to the introductory video and the survey were sent to avalanche practitioners through a variety of associations in the US, Canada and New Zealand.

The survey was anonymous and intended only for avalanche practitioners. No demographics were collected but the start date and number of winters in each phase of a practitioner's career were required.

Since the wording in the survey discouraged potential respondents who do limited ski cutting, the survey results better represent avalanche practitioners who frequently ski cut slopes.

The survey distinguished between five types of avalanche work (sectors): Lift-based ski areas (i.e. ski patrolling), mechanized ski guiding (for helicopter and snowcat skiing), non-mechanized ski guiding (for ski touring), highways and resource industries, backcountry forecasting (for public avalanche warnings), and a category for other types of avalanche work.

Each respondent could estimate their ski cuts and injuries for one or two career phases in which they did the most ski cutting. Each career phase was for one or more winters in a specified sector. For each career phase, respondents were asked to recall and estimate their average number of ski cuts per winter, number of winters, as well as the number of their near misses and injuries.

As is common for analyzing the risk to workers, respondents were asked about four types of events:

A *near miss* is an unplanned event that did not result in injury, illness, or damage, but had the potential to do so. Some respondents may not consider being caught in a D1 avalanche to be a near miss since such avalanches are, by definition, relatively harmless. Also, loose wet avalanches reliably start at—not above—the practitioner's skis so some respondents may not consider larger loose wet avalanches, e.g. Size D2, to be near misses.



A small dry slab avalanche triggered by a ski cut performed by Peter Schaerer who was in his 70s at the time. Photo Bruce Jamieson

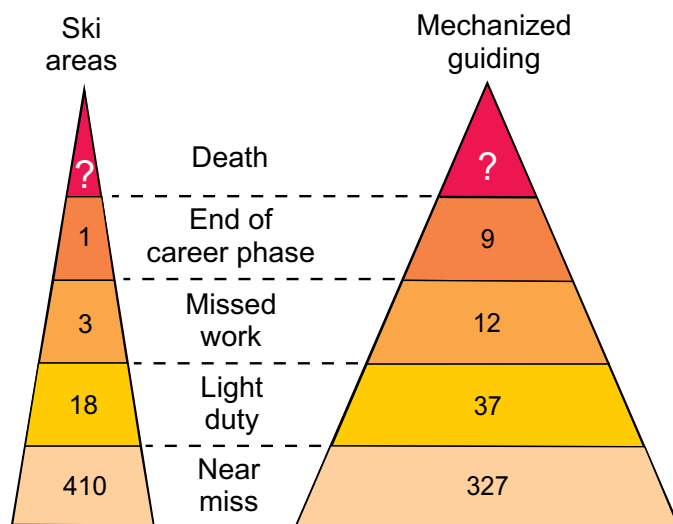


Figure 3: Risk (rate of near misses and injuries) per million ski cuts for ski areas and mechanized guiding. The bases of the triangles are scaled by the total injury rate (excluding near misses) for the sector as shown in Table 3.

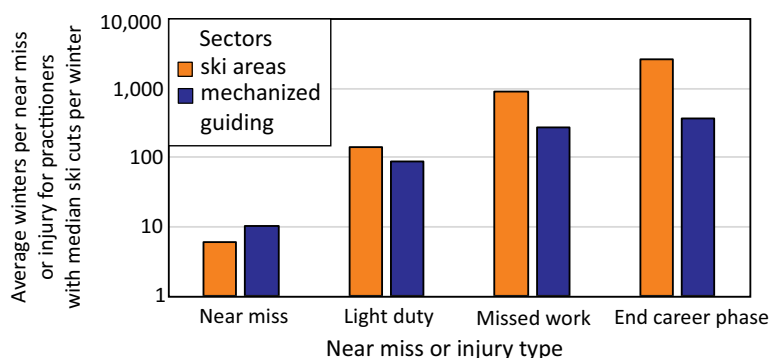


Figure 4: Estimated average number of winters per near miss or injury for practitioners with the median number of ski cuts per winter (Table 1). The left axis uses a log scale so that shorter columns, e.g. the average winters per near miss or light duty injury, are clearly displayed.

SECTOR	NEAR MISS	LIGHT DUTY	MISSED WORK	END CAREER PHASE
Ski areas	6	142	902	2,705
Mechanized guiding	10	90	270	360

Table 4: Average number of winters per near miss or injury for practitioners with the median number of ski cuts per winter from Table 1.

Light duty refers to a period of one or more days of paid work in which the injured worker does work that is physically less demanding, e.g. office work.

Missed work refers to a period of one or more days in which the injured worker is unemployed. The injured worker may receive some financial compensation but is not employed to perform their regular or light duties.

End of career typically refers to a career ending injury. Since the survey allows for a second career phase, e.g. forecasting for a highways avalanche program after a career phase as a ski patroller, this type of injury is referred to as end of career phase.

RESULTS AND DISCUSSION

Out of 161 respondents, 50 had complete answers for a second career phase, giving a total of 161 + 50 = 211 career phases of data for analysis. The career phases ranged in length from 1 to 38 winters with an average of 11 and a median of 9 winters.

Since many of the probabilities in this study are small numbers, e.g. 3×10^{-4} per ski cut, we report the frequencies as n events per million ski cuts.

Number of ski cuts per winter per respondent for the various sectors

Table 1 shows the number of career phases and number of ski cuts per winter and total for the different sectors. To our knowledge, the number of ski cuts winter for avalanche practitioners has not been previously reported.

Our analysis focused on ski areas (128 career phases) and ski guiding (45 career phases) because other sectors lacked sufficient data.

Triggering rate by avalanche size and sector

Figure 1 and Table 2 show that the triggering rate per million ski cuts decreases sharply with increasing avalanche size. When looking at the data for all sectors, about 35% of ski cuts result in avalanches that are D1-1.5 in size, with only 0.4% resulting in D2-2.5 size avalanches and only 0.014% resulting in size D3+ avalanches.

For Size D1 to 1.5 and D3+ avalanches, ski area practitioners reported a triggering rate about twice as high as ski guides (Table 2). For size D2 to 2.5 avalanches, the triggering rate is about 25% higher for ski guides than for ski area practitioners (ski patrollers).

Probability of being caught in a triggered avalanche during ski cutting by avalanche size and sector

Figure 2 shows that the probability of being caught in an avalanche triggered during ski cutting increases with the size of the triggered avalanche. There is little consistent difference in the rate of being caught between mechanized ski guiding and ski areas. Note that size D1 avalanches are considered relatively harmless (McClung and Schaerer, 2006).

Risk to practitioners: Near miss and injury rates from ski cutting

The numbers of reported near misses and injuries for ski areas and mechanized guiding are presented in Table 3. Only 7 and 4 injuries resulted in missed work, or ended career phases, respectively, so interpretations and extrapolations based on such limited data for serious injuries should be made with caution.

Figure 3 shows that the injury rate for mechanized ski guides per million ski cuts is approximately two and a half times the rate for ski area practitioners. This may be due to:

- Ski area practitioners having better options for explosive use on larger or more serious slopes,
- The slopes that ski area practitioners ski cut are often more ski compacted, reducing the frequency of deeper than expected slab avalanches, and
- Ski area practitioners may have a long prescribed list of slopes to ski cut when there is a small accumulation of new snow overnight, e.g. 5 cm (i.e. when the risk is very low).

For ski areas and mechanized ski guiding, the frequency or rate of near misses and injuries *per winter* can be estimated from Table 3 and the estimated number of ski cuts per winter in Table 1. However, the reciprocal of average frequency, i.e. average number of winters per near miss or injury, is a more intuitive way of comparing infrequent events. Table 4 and Figure 4 show the average

in the U.S., this suggests a probability of death of about 0.08 per million ski cuts. Allowing for uncertainty in the number of ski cuts per winter of half an order of magnitude on either side of this estimate, the range in the probability of death is about 0.02 to 0.2 per million ski cuts.

There are physical reasons why the probability of death while ski cutting should be lower than other activities in avalanche terrain. Avalanche practitioners performing ski cutting will have a low vulnerability because they are more often caught on skis while high in the start zone (which reduces the avalanche mass and force on the practitioner), the ski cutting teams are skilled in companion rescue, and the ski cutting occurs within operations with good avalanche rescue capability.

RECOMMENDATIONS

We recommend a study of the risk of ski cutting for the sectors with limited survey responses in this study, specifically non-mechanized ski guiding (for ski touring), highways & resource industries, and backcountry forecasting for public avalanche warnings.

We recommend that operations keep comprehensive records of ski cutting and any injuries so that recurring factors in near misses and injuries can be identified and mitigated.

winters per near miss or injury for the two sectors with the most data.

Table 4 shows that the average winters per event increases with the seriousness of the injury. Also, the average winters per injury for mechanized ski guiding are fewer than for ski area practitioners because mechanized ski guides reported more frequent injuries than ski area practitioners.

The average number of winters per injury within an operation can be roughly estimated by dividing the numbers in Table 4 by the typical number of practitioners engaged with ski cutting. For example, for an operation with 50 practitioners, the average winters per ski cutting injury resulting in light duty would be $142/50 \approx 3$ years for a ski area and $90/50 \approx 2$ years for a mechanized guiding operation. Avalanche operations can use this approach to check if their rate of near misses and injuries are roughly comparable to those in this study. However, the duration of near miss and injury records should preferably be at least three times as long as the average number of winters per near miss or injury in the comparison (i.e. an average of 10 winters per near miss is best assessed over 30 or more winters).

Discussion on the probability of being killed in an avalanche while ski cutting

This survey relied on each respondent's recollection and hence yielded no data on deaths. However, the probability of a practitioner being killed in an avalanche while ski cutting can be estimated based on U.S. data for the last 40 winters. Greene et al. (2014) estimated that there are about 2780 avalanche practitioners in the United States. Assuming two thirds of these practitioners ski cut the average number of slopes per winter (Table 1), then there are about one million ski cuts per winter in the United States, i.e. about 40 million ski cuts over the last 40 years. Since three practitioners have died in avalanches while ski cutting

While some avalanche operations have shared their ski cutting procedures, we recommend that procedures be widely shared within sectors so that best practices can be established and published.

We recommend that operations keep comprehensive records of ski cutting and any injuries so that recurring factors in near misses and injuries can be identified and mitigated.

ACKNOWLEDGMENTS

We recognize that the survey was difficult and are grateful to those that completed the survey.

Our thanks to Craig Wilbour, Steve Conger, Mark Klassen, Colin Zacharias, Forest Latimer, Scott Davis, Scott Savage, Mark Grist and John Buffery for discussions on ski cutting and/or comments on the draft survey.

We would like to thank Dan Kaveney from the American Avalanche Association, Sarah Carpenter from the American Mountain Guides Association, and Alex Kittrell from HeliSki US for distributing the survey to their respective members.

For distributing the survey in Canada to their members, we would like to thank the Canadian Avalanche Association, the Association of Canadian Mountain Guides, and the Canadian Ski Guides Association.

Irene Henninger and Doug McCabe provided insights about the similarities in ski cutting practices between the U.S. and New Zealand.

Our thanks to Andy Hoyle and the Ski Areas Association of New Zealand (SAANZ) for distributing the survey in New Zealand. ●

REFERENCES

- Canadian Avalanche Association. 1985. Advanced Avalanche Awareness Course for the Winter Recreationist, Canadian Avalanche Association, Revelstoke, BC, Canada. Available on www.snowavalanchearchive.com.
- Daffern, T. 1992. *Avalanche Safety for Skiers and Climbers*. Rocky Mountain Books, Calgary, Canada.

- Greene, E., Jamieson, B., and Logan, S. 2014. Fatal occupational injuries of avalanche workers in North America, Proceedings of the 2014 International Snow Science Workshop. Banff, Alberta, Canada, 293-299.
- Jamieson, B. and Geldsetzer, T. 1996. *Avalanche Accidents in Canada*, Vol. 4, 1984-1996. Canadian Avalanche Association, Revelstoke, BC, Canada.
- LaChapelle, E.R. 1970. *The ABCs of Avalanche Safety*, 2nd edition, Colorado Outdoor Sports Co., USA.
- McClung, D.M. and Schaerer, P.A. 2006. *The Avalanche Handbook* (3rd ed.), The Mountaineers, Seattle, USA.
- Perla, R.I. and Martinelli, M. Jr. 1976. *The Avalanche Handbook*, USDA Forest Service, Fort Collins, CO, USA. Available on www.snowavalanchearchive.com.
- Richmond, D. 1994. Repeated mistakes by avalanche professionals. Proceedings of the 1994 International Snow Science Workshop in Snowbird, Utah, USA.
- Seligman, G. 1936. *Snow Structure and Ski Fields*. International Glaciological Society, Cambridge, England.
- Stimberis, J. 2008. Chinook Pass: 25 years on. Proceedings of the 2008 International Snow Science Workshop in Whistler, BC, Canada.
- Stimberis, J. 2018. Perspectives on ski cutting. Proceedings of the 2018 International Snow Science Workshop in Innsbruck, Austria.
- Vesely, M. 2014. Zen and the art of skier controlled avalanche release – perspectives on key risk indicators in ski cutting. Proceedings of the 2014 International Snow Science Workshop in Banff, Canada.
- Wilbour, C. 1986. The Chinook Pass avalanche control program. Proceedings of the 1986 International Snow Science Workshop in Lake Tahoe, California, USA.
- Wilson, N.A. 1974. *Avalanche Control*, a chapter in *Avalanche Courses (for avalanche practitioners)*, National Research Council of Canada / BC Institute of Technology. Available on www.snowavalanchearchive.com.



Dave Aikens, avalanche forecaster, ski cutting in Easter Bowl at the Fernie ski area around 1982. Routine ski cutting with no remarkable story. Dave is now retired, and has taken an interest in this study. Photo Bruce Jamieson

a reflection on 2018-2019's

NOTABLE WINTER



Driving through a recently plowed and opened road at a Lebanese Ski Resort, 20 May 2019. Photo Roz Reynolds



Heavy snowfall of the 2018/19 winter led to heavy runoff, feeding waterfalls like this one in Bsharri, Lebanon, 20 May 2019. Photo Roz Reynolds

BY ROZ REYNOLDS

I traveled to Lebanon for the first time this spring and was blown away by the community and the landscape I found there. Along with deep gorges studded with waterfalls and vast limestone walls, I was surprised to also find unmistakable evidence of a winter with dramatic snowfall. The mountains were still snow-capped and some roads, only just opened, were surrounded by massive piles of snow. Upon talking to locals, I heard that it had been an unusually high snowfall that winter. I was unable to obtain much information on avalanches for the 2018/2019 season and it is unclear if there are any avalanche forecasting programs in place in Lebanon, but this high snowfall winter of 2018/2019 definitely had a familiar ring to it.

Like Lebanon, Colorado, where I reside, also had an exceptional winter which provoked a historic avalanche cycle. This March, the Colorado Avalanche Information Center (CAIC) issued avalanche warnings in most of the backcountry zones of Colorado and most were labeled extreme or high avalanche danger for a period of time. In the history of the CAIC, there had never been four backcountry zones listed as extreme before March of 2019.

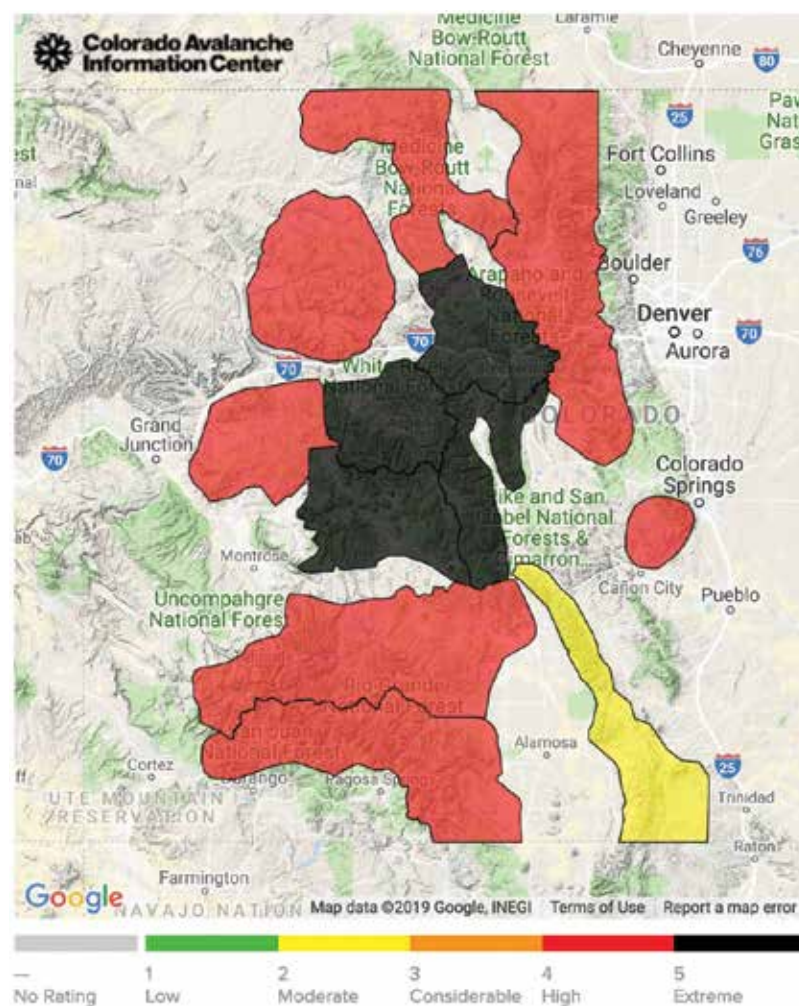
Furthermore, what was fascinating was how widespread the avalanche danger and high precipitation was throughout the state of Colorado. The effects of this can be further analyzed later in the season. For example, in May, it was (and is still today) reported that 0% of Colorado is in drought according to the National Integrated Drought Information System (Drought.gov) and in June the Gunnison watershed was a shocking 52,350% of normal.

These numbers are truly astounding, but what I found even more interesting were the reports of other places in the Northern Hemisphere that also had similar winters. As of 21 August 2019, Nevada, California, Wyoming, Utah, and Arizona, as well as plenty of midwestern and eastern states also currently have 0% of the state's population in drought (see Figure 6 below). On 22 January 2019, record breaking snowfall of 350 cm since the beginning of the season was reported in Happy Valley-Goose Bay, Labrador, Canada. While skiing at Whistler at the end of April, I found the same deep snowpack into the spring.

Reports from other parts of the world revealed similar weather reports. According to the World Meteorological Organization, "The Indian Meteorological Department issued warnings on 21 January (2019) of heavy or very heavy rain and snow for Jammu and Kashmir and Himachal Pradesh, prompting warnings of avalanches amid an intense cold wave."

The World Meteorological Organization reported, "The start of 2019 has been marked by high impact weather in many parts of the world, including record heat, wildfires and rainfall in South America and Australasia, dangerous and extreme cold in North America, and heavy snowfall in the Alps and Himalayas."

This year, the Alps experienced their second season in a row of heavy snowfall. From Wyssen Avalanche Control based out of Switzerland: "A record winter in the Alps has kept the safety officers in charge of traffic routes and ski areas on alert throughout the winter season. In the 2017/18 season, the highest avalanche warning level 5 was issued in Austria for the first time since the avalanche winter of 1999, and the winter of 2018/19 was no dif-

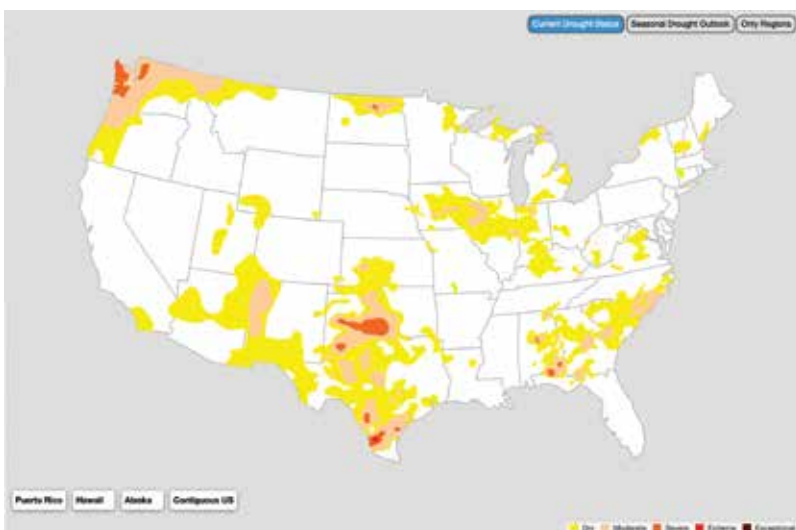


Screenshot from the CAIC Forecast, 7 March 2019.



As extreme weather brings extreme conditions, new avalanche solutions such as ways to control avalanches remotely are gaining traction due to the increased safety and efficiency.

Avalanche on I-70, March of 2019 marked a historic avalanche cycle not only in the Front Range, but around the state, 5 March 2019. Photo Roz Reynolds



Screenshot from Drought.gov, 21 August 2019.

SR-210, the road up Little Cottonwood Canyon of Utah, was hit by an unexpected mudslide on 8 August that brought down large boulders and closed the road for several days.

The Winter of 2018/2019 showed exceptionally high snowfall across the Northern Hemisphere and will surely be noted in the records of history, especially in places like Colorado. Was the extreme weather of last winter outstanding, or does it mark the beginning of a trend for years to come? As the Northern Hemisphere passes into fall, we eagerly await what the winter season ahead of us will hold. ●

REFERENCES:

- <https://www.drought.gov/drought/>
- <https://www.9news.com/article/news/local/next/snowpack-in-the-gunnison-basin-is-more-than-52000-percent-above-average/73-853337c9-ab95-4eb7-ac20-445327eb7404>
- <https://avalanche.state.co.us/>
- <https://public.wmo.int/en/media/news/2019-starts-extreme-high-impact-weather>
- <https://www.wyssenavalanche.com/en/news-post/avalanche-warning-level-5-wyssen-systems-withstood-the-extreme-situation/>

ferent from its predecessor. Persistent precipitation in record-breaking quantities caused extreme avalanche danger in many places.”

As extreme weather brings extreme conditions, new avalanche solutions such as ways to control avalanches remotely are gaining traction due to the increased safety and efficiency.

This was the second big winter in a row for the Alps and avalanche control teams had to work around the clock to keep roads open and the population safe. This has led to more discussion of remote avalanche control systems and solutions to handle extreme weather conditions.

Avalanches have not been the only natural hazard of 2019. Mudslides have also proved to be problematic in the Western United States this year. Fortunately for Colorado, the spring offered cooler temperatures and not a rapid increase in temperature which would have led to flooding given the heavy snowpack. In fact, Steamboat Springs received a notable amount of snow on the summer solstice. But heavy runoff did come and I happened to witness it firsthand. While driving on Highway 50 near Gunnison, Colorado, I was stopped by a sudden mudslide across the road. Fortunately, the road was not blocked for long and soon traffic could continue as usual. Another more notable mudslide closed the road on I-70 in Colorado on 26 July. Additionally,



Heavy Snowfall in Davos Switzerland, Winter 2018/2019. Photo Walter Steinkogler



NAC: Chugach National Forest Avalanche Center forecaster Aleph Johnston-Bloom searches out the perfect pit site on Turnagain Pass in April of 2019. Photo Karl Birkeland



NOTABLE WINTER

2018–2019 avalanche center season summaries



NATIONAL
AVALANCHE
CENTER

The 2018/19 winter was a big one across large areas of the U.S. Our avalanche centers issued warnings 63 times for a total of 192 National Weather Service zones. Interestingly, we almost doubled the 2017/18 total of 34 warnings.

An additional challenge this winter was an extended federal government shutdown. Though many federal employees were furloughed, the NAC worked with Forest Service leadership to categorize avalanche center and artillery program employees as critically important to public safety, thereby allowing them to work during the furlough. This period wasn't easy and we want to thank everyone for their hard work and dedication. We had some challenges at the National Avalanche Center as well. Simon stepped away from

the NAC to take an interim position as the Director of Forecasting for the Northwest Avalanche Center. NWAC is undergoing some changes, and Simon was able to contribute while also gaining valuable experience at one of our oldest and best-established avalanche centers. Karl weathered Simon's absence, the government furlough, and made sure the wheels didn't come off the bus with either the avalanche center program or the military artillery for avalanche control program. At the end of the winter Simon returned to the NAC, and we have a full slate of summer projects which will benefit from the help and expertise of Zach Guy and Chris Lundy.

Throughout all the challenges, avalanche centers continued their fantastic public safety work. Avalanche center websites reached over 1.6 million unique visitors, and those visitors accessed our avalanche safety products 12 million times, including over 6.5 million accesses to avalanche forecasts. In addition, avalanche centers and associated friends groups provided free and low-cost avalanche education to tens of thousands of peo-

ple. They also continued to be a model program for partnerships, with partners and communities contributing over two thirds of their required funding.

It is mid-May and the avalanche fatality total for the 2018/19 winter stands at 25. This includes 14 skiers, eight snowmobilers, one snowboarder, and two fatalities due to roof avalanches. Though any avalanche fatality is too many, we are heartened that the long term average for avalanche fatalities has remained relatively steady for the past 20+ years at about 25 to 30 fatalities annually. This steady fatality number, combined with the dramatic increases in the use of the backcountry, mean that the avalanche fatality rate has dropped dramatically over that same time period. This continues to be an affirmation of the excellent work being done by the entire avalanche community.

In closing, we want to offer up a huge thanks to all of you who support avalanche centers and we'll leave it to them to give you some of the highs and lows from this past season.

—Karl Birkeland and Simon Trautman



NWAC: 12/31/2018 Icicle Creek (outside of Leavenworth, WA): Remotely triggered slab on 10–15 cm of surface hoar over a pencil hard, wind packed layer in Icicle Creek—E aspect at 6,200'. Incredibly reactive conditions were found three days after the most recent storm. Photo Matt Primomo, NWAC



NORTHWEST AVALANCHE CENTER

The 2018/2019 season was marked by a fundamental shift in the Northwest Avalanche Center's forecast staff and operations. For the bulk of four decades, the center was staffed by three US Forest Service Avalanche Meteorologists based in Seattle. Even though the program was supplemented by a professional observer program and local industry partners, USFS forecaster field time was minimal (compared to today's program) and the workload became unsustainable over time. As an organization, we recognized that we needed to improve and modernize our public avalanche program to meet the increasing back-country use in our region.

In the spring of 2018 (after many years of planning and positioning), we began the transformation from a centrally located office based program with three staff to a more dispersed program with eight staff and a strong field presence. Simon Trautman of the National Avalanche Center was brought onboard in an interim capacity to lead the transition. Long time forecaster and retiring forecast director Kenny Kramer helped with the transition by staying on in a supporting role. Dennis D'Amico and Robert Hahn streamlined the weather forecasting program. We expanded our



NWAC Staff, November 2018. Back Row (L to R): Scott Schell, Charlotte Guard, Cheri Higman, Lee Lazzara, Matt Schonwald, Kenny Kramer, Dallas Glass, Josh Hirschberg, Dennis D'Amico, Andrew Kiefer, Simon Trautman. Front Row: Ian Nicholson, Jeremy Allen, Robert Hahn, Matt Primomo, Laura Green (passed away December 2018).

avalanche forecasting program and created satellite operations in Bellingham and Leavenworth. Dallas Glass, Josh Hirshberg, Andrew Kiefer, and Matt Primomo worked hard to establish the new field based avalanche forecasting program.

The non-profit arm of NWAC helped smooth our operational leaps with direct financial support for the forecast team and a tailored professional observer program. Additionally, the non-profit expanded NWAC's educational offerings both in number and user type and dramatically increased our social media presence. (see article on page 13)

NWAC's changes truly reverberated into all corners of the program and required a mix of new and existing employees to band together. These changes not only increased the accuracy and resolution of our products, they created an exciting amount of public buy-in and interaction with our center. Public observations and social media engagement jumped—a trend that we expect will continue as we further refine and build the forecasting program.

After a late start to winter and forecasting (December 9th!), the first half of the winter ended

up warmer than normal with a typical cadence of Pacific storms. 10 out of our 11 days with avalanche warnings were issued between Dec. 10th and Feb. 15th. One notable system in late December brought record winds to the Mt. Baker Ski Area, with five consecutive hours of gusts above 100 mph (peaking at 120 mph) on Dec. 20th.

As we stepped into February, a cold snap brought temperatures 2-5 F colder than normal (source WA State Climatologist) through early March. Low elevation snow was common during the February cold snap (almost two feet of snow in Seattle). East of the Cascade Crest, slopes had enough coverage for backcountry travelers (and avalanches) to frequent the low elevation sagebrush hills of the Columbia Plateau. Places like the city of Wenatchee saw skis and snowmobiles in the surrounding foothills and even within city limits. A significant dry stretch accompanied by a gradual warming trend made for a quiet mid to late March. Backcountry traffic and website usage tapered as the good snow conditions from earlier in the month eroded. The season ended with a bang in Oregon; Mt. Hood saw about a foot of WE over 10 days in early April as the snow line oscillated between 5000' and 8000'. Massive D3 to D4s released from the upper start zones of the volcano, many running several thousand feet through the major canyons. When winter was all said and done, our snowpack (WA Cascades, Olympics and Mt. Hood, OR) landed between 60-80% of normal on Apr. 1st.

Following a tragic 2017/18 season with 7 fatalities over a deadly 3 week span, our region was spared from avalanche fatalities in 2018/19. That said, we witnessed a number of very close calls, especially over the more active first half of the winter.

We would like to remember two special individuals we lost this season. Long time Mt. Hood Meadows ski patroller Laura Green passed away December 6th, 2018 during a wind surfing accident on the Columbia River. While Laura was a NWAC professional observer for the last several seasons, we will especially remember the support she gave the forecast center over the decades—it was a pleasure to work closely with Laura on avalanche forecasts for the Mt Hood area. We also want to recognize the passing of NWAC Board Member Tab Wilkins. Tab died March 23rd, 2019 from injuries related to a fall while skiing on Decker Mt. near Whistler, BC. Tab was an energetic board member whom we will miss dearly.

—Simon Trautman, Dennis D'Amico, and Josh Hirshberg



IPAC: Schweitzer patroller Charley Nish pulled out his camera during one of last winter's early morning avalanche routes in Northbowl at Schweitzer.



IDAHO PANHANDLE AVALANCHE CENTER

WEATHER AND SNOWPACK

In North Idaho and Northwest MT, the winter of 2018/19 started with a much anticipated El Niño on the horizon and a long-range forecast that made us think that we'd better get our rain jackets ready. We were preparing for a warm, wet and below average snowfall winter. A weak El Niño did show up and provide expected conditions in December and into January. February brought

dramatic changes to the Idaho Panhandle and Northwestern Montana though. The arrival of an active jetstream brought moisture to the region, while several cold air intrusions from the north kept temperatures well below normal. Several locations finished in the top five for February snow totals and in the top 10 for coldest month on record. February's average temperature was 11.5 degrees colder than normal. Kellogg ID saw the 4th snowiest month on record last February. The town experienced 18 days of snow with a total of 29.3". It was also the 4th coldest month on record for Kellogg, ID. There was a period from February 8th through the 15th that was particularly snowy as cold air from the north collided with moisture from the southwest.

From a snowpack perspective, two novelties in our weather patterns during February forced us to look at the avalanche conditions differently. First, north winds were 180 degrees from normal and persisted for weeks. In February, the prevailing winds are normally out of the southwest and they create heavier snow that isn't as susceptible to wind transport.

And secondly, February was cold enough to produce light density snow which is more susceptible to transport. Places that normally see loading and cornice building were flattened and stripped of snow. Avalanche starting zones that are usually leeward became windward as the wind moved a lot of light density snow in and out of starting zones. Even though February was bitter cold and far from the norm, it helped save our season. Not only did the cold preserve the snow but, in most areas, increased the depth. Even though annual snow totals were around 80% of average, the season was well preserved into May because of the cold and snowy February that delayed the turn to spring.

EDUCATION AND OUTREACH HIGHLIGHTS

The avalanche safety message continues to grow. We're excited to see so much interest and involvement from the local communities. IPAC's education program continues to grow and change to meet the needs of the local public.

- The 'Snowpit Chats' series continues to be a great way to get local winter recreationists together for social engagement and avalanche education. We put on the Snowpit Chats one evening a month at the Matchwood Brewing Co. in Sandpoint, ID. Last season we hosted four Snowpit Chats. Our goal for next season is to grow the series to some of the other communities in our forecast region like Coeur d'Alene, ID; Spokane, WA; and Libby, MT. Thank you to our speakers last season: Tom Eddy, Dick Richmond and Sam Kavanaugh. If anyone is interested in visiting North Idaho and speaking at a Snowpit Chat, let me know. thompsonipac@gmail.com
- IPAC had a chance to teach an avalanche course to Timbersled riders. Timbersled is part of Polaris Inc. but manufactured and product tested in North Idaho. It was the 1st time we've taught a class to just snowbikers. Snowbikes are gaining popularity locally. 35-45% of the motorized use in the forecast area are now snowbikes. We look forward to teaching class and working with Timbersled in the future.
- Thank you to our local ski areas for continued support: Lookout Pass Ski Area, 49 Degrees North, Silver Mountain Resort, Schweitzer Mountain Resort, and Selkirk Powder.
- As our avalanche education grows so does our Instructor pool. Thank you to our new IPAC Avalanche Instructors: Gabe White, Larry Banks, Kim Loosemore, and Cass Higgins. We're excited about having you on our team and look forward to teaching more classes!

—Jeff Thompson



FLATHEAD AVALANCHE CENTER

If Northwest Montana's 2018/19 winter went to a shrink, it might be diagnosed as having multiple personality disorder. The season swung between wet and dry poles, with an atypically sustained cold period midwinter. The most prolonged – and unusual—avalanche cycle—began in mid-March and involved unexpectedly destructive wet snow avalanches.

One personality, "Soggy, Warm, and Wet," bookended the season. A sustained mix of rain and snow marked the end of October and the beginning of November. Although SNOTEL stations above 6000 feet recorded six to nine inches of precipitation in the period, only 40-50% of that accumulated on the snow pillows. This personality resurfaced in April, which proved to be one of the wetter Aprils on record. Five to ten inches of SWE accumulated in the first three weeks of the month, two to three times the average for the period. The only other interval of sustained snowfall occurred in December, and these three wet chapters—seven weeks of the season—accounted for 45 to 50 percent of the season's total snowfall.

The second personality, "Bitter Cold and Dry" dominated mid-winter. It was characterized by regular bouts of Arctic air spilling over the Continental Divide, with air temperatures stuck well below zero for days on end. While weather like this is not uncommon in the Flathead Valley, it is unusual to see northeasterly flow prevail for five weeks, unbroken by warmer southwest flow. The dense, cold air spilling through low passes on the Divide is typically channeled to valley bottoms, but this winter we saw multiple episodes in which strong to extreme northeasterly winds raked normally sheltered terrain. FAC forecasters found it difficult to predict these events, and the lack of automated winds sensors in the Flathead and Swan Ranges often left us driving highways to vi-

sually determine which slopes were wind-affected by checking where snow remained in the trees.

Occasional pulses of moisture overrunning the cold air entrenched in the valley contributed to a deepening but weak snowpack at low and mid elevations. This made for straightforward access and quality riding conditions – no rain crusts on approaches and exits! However, this low-density snow contributed to an unusually destructive wet snow avalanche cycle in mid to late March, when temperatures returned to seasonal values. Wet loose slides initiated by solar warming gouged into the weak snow left by the mid-winter cold spell, ran full track, and spilled trees and dense debris across groomed snowmobile trails. We observed widespread D3 wet loose avalanches. A cycle of very large wet slab avalanches followed as mountain temperatures spiked near 60 degrees F with poor overnight freezes. Many paths produced repeated wet avalanches as generations of the entire winter's snowpack came unglued. Glide cracks opened, and some failed as catastrophic avalanches. The prolonged warming and extensive avalanching prompted the FAC to issue two days of High danger and an Avalanche Warning on March 21 before clouds and colder temperatures put an end to the cycle. It felt bizarre to have flashing red on the forecast while walking around in short sleeves under clear skies. We received only one report of a near-miss during the cycle: a group of inbounds snowboarders at Whitefish Mountain Resort triggered a large wet slab while riding in closed terrain.

The season's two most serious accidents occurred January 5, at the close of three snowy weeks. In one, a cornice collapsed beneath a snowbiker standing on a ridge in the Swan Range. The cornice fall carried the rider over several cliff bands and subsequently triggered a large avalanche. He was fully buried, but fortunately his partners dug him out, and a rescue helicopter winched him from the scene. He is still recovering from his life-threatening injuries. On the same day, a snowmobiler was killed in a very large, hard slab avalanche on the Rocky Mountain Front, east of our forecast area. He was fully buried by the

FAC: FAC Director Zach Guy and his partner find debris from a D3.5 wet loose avalanche during an early morning ski in Glacier National Park. March 19, 2019. Photo FAC





FAC: FAC volunteers Zack Gidley and Jeff Dobronyi investigate a crown that failed on early season weak layers above Skiumah Lake, Flathead Range. December, 2018. Photo FAC

slide while watching a rider higher on the slope. The victim was not wearing a beacon. The other rider, who triggered the slide, was not buried and survived with relatively minor injuries. FAC staff visited the site and issued a report at the request of the local SAR team. NW Montana continues on a trend of one fatal accident per year.

While our website continues to serve as our primary host for avalanche information, the FAC continues to develop and improve its social media content, and our efforts are reflected in significant growth during the past two years. Our messaging focuses on clear, tangible travel advice supplemented by informational photos and videos, with the goal of steering users to our website while engaging them more frequently with avalanche information and short learning moments. We provide daily morning social blasts that coincide with our forecasts and afternoon updates of observations from the field or notable incidents. New this year, the FAC began daily avalanche information broadcasts on four regional radio stations.

Among the season's accomplishments, we:

- Issued 119 daily forecasts for three forecast regions, along with 13 pre- or post-season information updates
- Published 209 staff field observations, an increase from 172 visits last season and 105 the season before. We published 232 observations crowdsourced from public users or professional partners. Our observations page is second in popularity only to the homepage.
- Produced 80 field videos, over four times as many as two seasons ago. Our videos were viewed over 55,000 times. Our most popular videos were investigations of the cornice-fall accident and snowmobiler fatality.
- Hosted a new professional development seminar in Hungry Horse, MT in November. The seminar catered to regional professionals in avalanche, search and rescue, and law enforcement.
- Taught more classes than any season to date, despite an unprecedented number of classes canceled due to bitter cold weather mid-winter. We partnered with our Friends group to teach 46 classes to over

1700 students. Our education coordinator, Jenny Cloutier, has done an incredible job of orchestrating a symphony of classes to meet the overwhelming demands for avalanche education in the Flathead Valley.

- Volunteers donated approximately 844 hours of field time towards FAC operations, and FOFAC board members and volunteers contributed 645 hours to avalanche education, outreach, events, and fundraising.

Community feedback has been overwhelmingly positive. These successes would not be possible without the dedication and support from our community and partners. From all of us at the FAC (Zach Guy, Blase Reardon, Mark Dundas, Clancy Nelson, Guy Zoellner, and RJ Hannah), thank you to everyone who contributed time or resources towards avalanche safety in the Flathead Valley.

—Zach Guy



PAYETTE AVALANCHE CENTER

We started our forecast season on December 12 with leftovers from a series of fall storms that formed a 25cm thick faceted base in our snowpack for the first half of the winter. December was a combination of cooler than average temps combined with frequent, low SWE storms that allowed for incremental loading of the basal facet problem. Boot, ski, and sled penetration were nearly bottomless until January. The basal facets and the conditions that allowed them to persist created an atypical scenario and our messaging reflected this especially as the overlying snowpack began to consolidate into a more cohesive slab.

Early January added wind slabs and a surface hoar layer to the equation. By mid-January high pressure and rounding facets near the ground were inspiring confidence and easy travel conditions. The January high pressure snowpack evolved into go-anywhere conditions just before the fire hose pointed our way on January 18 with a warm

sn[❄]wmetrics.com



970-482-4279

Pacific storm that added 2.5 inches of SWE in three days, creating a short lived period of instability and eventually consolidating the snowpack enough to put the early season concerns to bed. Extended high pressure persisted through the end of the month and created solar and melt/freeze crusts on all but the shadiest aspects.

Cue the drumroll, as was the case in many places across the West, February turned into Snowpocalypse...storms lined up for most of the month, schools were closed, and avalanche cycles came and went with each week, many going unnoticed because folks were either not venturing into our bigger avalanche terrain or couldn't see what was happening. In between storms, backcountry travelers found crowns and debris from various avalanche cycles, confirming our Considerable and High danger hazard levels. For the most part, the snow came in right-side-up with short periods of instability; each storm improved the skiing and riding. By mid-February the snowpack was becoming more stable with shallow storm slabs and ridgetop wind slabs being the primary concerns. Persistent Weak Layers and Deep Slab Instability were a thing of the past.

Local Snotel sites recorded 14-16 inches of SWE around 6500 ft. with 45-56 inches of settled snow during the month of February. Upper elevation storm totals were upwards of 150 inches throughout the same period. Temperatures in the valleys remained cool and snow accumulated in the lower elevations almost as fast as up high. The schools were closed more than they have been in the last 25 years, roads were impassable at times and EVERYONE got their share of POW!

March came in drier and temperatures warmed. By mid-March powder season was over and an incredible corn cycle capped the winter season. The coverage throughout the West Central Mountains was simply shocking. February provided a smooth, deep blanket of snow that allowed easy access to many hard to get to locations. Overheating sleds and sunburn became the primary concern for the rest of the PAC forecasting season.

April not only marked the end of the season for PAC, but also marked a spring wet slab avalanche cycle with very large avalanches occurring in steep river canyons as temperatures warmed and rain weakened the snowpack. Many of these occurred in terrain that had been burned in the last 20 years and produced debris piles that were very large and full of dead trees. Some of these caused major damage to backcountry roads and rerouted streams.

High and low lights of the PAC season: We'll start with the lows- the partial government shut-



PAC: April Wet Slab cycle. Photo Dave Williams/Midas Gold

down impacted an existing grant that we had received; we were unable to meet the criteria for the grant and lost funding that would have funded our avalanche education and a portion of the forecaster payroll for the season. The loss of funding resulted in both seasonal PAC forecasters going to part time (intermittent status) for the remainder of the season with a three-day per week advisory issued. In addition, the PAC is still unable to fund the vacant Director position which has created an administrative and oversight hole in our organization for the last three seasons. Funding is a major problem for the PAC and due to the terms of the shutdown, we were unable to utilize our Volunteer Travel Companions for part of December and all of January which limited PAC forecasters to working the same days.

On the bright side, PAC was able to utilize 130 volunteer hours through the remainder of the season and received more public and outfitter observations than in years past. Our Friends group went through a significant reorganization, stepped up their support with multiple fundraisers and provided funding for several equipment repairs and other bills that were not in the USFS budget or would have shut us down during the furlough. Throughout the 18/19 winter, PAC produced 53 forecasts which was the lowest number for any winter since 2008.

The best news of the season is that the Friends will continue to augment PAC's federal budget for 2020 and there is a resolution being pushed forward to the Idaho Legislature this year to utilize \$1 out of all snowmobile registrations in the state to create a grant program for the three Idaho Avalanche Centers, beginning in 2021. If this passes, it could provide a much needed financial boost for the PAC's long term future.

—Dave Bingaman



WEST CENTRAL MONTANA AVALANCHE CENTER

The 2018/2019 season was complex and variable. We started issuing early season snowpack updates on Halloween and began advisories the first week of December. East winds, Elk triggered avalanches on Mt. Jumbo above the city of Missoula, and a wildly complex and variable snowpack were themes for this winter.

WCMAC: Western Central Montana forecaster Todd Glew reports that this avalanche that he intentionally triggered in Sweeney Creek in the Bitterroot was the largest slide he's ever kicked off.



The factor we struggled with all winter was predominate east winds in our advisory area. These winds loaded slopes in unusual patterns and created shallow snowpacks on other aspects. We lost one of our wind stations and were not able to get the parts to fix it till summer. We relied on fieldwork and observations to assess the distribution of wind slabs. We changed our messaging to address this factor. We treated the wind slabs in our advisory more conservatively by adding more pictures and videos of active wind loading and where we were finding wind slabs in the field.

The weather this year was atypical in below average temperatures for our region. This led to many layers of buried surface hoar and basal facets. These layers were distributed in our area sporadically and led to more conservative decision-making, surprise test results, and near misses. We addressed this in our messaging by providing more videos and pictures to help portray the variability of snowpack structure and weak layers in the region.

Late February brought more east winds and a blizzard warning for the areas around Missoula. Below average temperatures left snow on the valley floor and surrounding foothill terrain around the city of Missoula. The weather pattern and snowpack were very reminiscent of the conditions that led to the urban avalanche on Mt. Jumbo in 2014. The WCMAC assessed the avalanche conditions, and the city closed access to Mt. Jumbo. We were on our way to look at the snowpack when we saw a small elk triggered avalanche on the face of Mt. Jumbo. The slide did not reach the valley floor. The avalanche conditions on Mt. Jumbo were very similar to what we found in 2014. We worked with the city to get avalanche information to the residents near the base of the mountain and why the closures were necessary.

We held two press conferences with the city to get information to the public and press. We advised the city on ways to keep residents safe, and we answered questions about the snowpack assessments and best practices for safety. The city took the lead on answering phone calls and public relations. The division of tasks allowed us to focus on snowpack stability and avalanche conditions in the foothills of Missoula and our normal advisory area.



SAC: February's big dumps fell on what was an abnormally thin, weak, faceted early season snowpack. Our largest avalanche cycle of the season occurred from February 25th through the 28th. During this 5-day storm, 7" of SWE pushed monthly totals to 10-15" of SWE throughout the advisory area. Photo Sun Valley Heli Ski

Mt. Jumbo is on Missoula city land and outside of our advisory area. The 2014 avalanche and this year's avalanche conditions have allowed us to work out a long term MOA for how to proceed in the future when weather and avalanche conditions present themselves. We are creating an avalanche atlas for the city and working closely with emergency preparations, plans, and training.

Overall the season was a success.

- 0 fatalities
- 102 Forecaster Field Days
- 64 Advisories
- 2 Avalanche Warnings
- 2 Late Season Snowpack Updates
- 5 Early Season Updates
- 2370 Education Participants—a new education record
- 57 education events

—WCMAC Staff



SAWTOOTH NATIONAL FOREST AVALANCHE CENTER

On April 8th, a series of texts lit up my phone as I drove home. "You hear about the slide out Warm Springs?" "Hit a house." I flipped a U-turn and headed back to Ketchum. Warm Springs Creek flows into the Big Wood River on the west side of Ketchum. The mouth of the drainage is densely populated, surrounding a base area for Sun Valley Ski Resort's Bald Mountain. To the west, the popular sidecountry terrain—known locally as "The Burn"—extends down a 1.5-mile long ridge. Cresting a rise, The Burn came into view along

with a patchwork of wet slab crowns and the tell-tale smear of dirty snow and piles of burned trees that formed a black, 1500' stripe to the valley floor.

It was apparent that my third-hand text message tip was grossly understated. At least two D3 wet slab avalanches had converged to impact three homes, two of which were completely destroyed—displaced from their foundations and missing their lower levels. The main tongue of debris was an estimated 40' deep and packed with both live and burned timber well over 18" in diameter.

Slides of this magnitude were not uncommon this season. On February 15th in the Lake Creek drainage north of Ketchum, several D2s and at least one D3 ran full track, impacting two homes. One slide blew through the back wall of a house, filled the master bedroom, and pushed six feet of snow down an open hallway, right past the owner who was sitting on her couch. Between the nights of February 25th and February 26th, avalanches crossed the Big Wood River and slammed into two homes, hurling snow, trees, and rocks the size of watermelons into common areas and bedrooms. During this same period, a slide impacted a home not six blocks from Ketchum's main drag.

I'd be remiss not to mention the historic deep slab avalanche cycle of February 25th through the 28th. During this five-day storm, 7" of SWE pushed monthly totals to 10-15" of SWE throughout the advisory area. February's big dumps fell on what was an abnormally thin, weak, faceted early season snowpack. In one small 17-square-mile subset of the Boulder Mountains, SAC staff documented more than 50 D2.5-D4 avalanches with combined crown widths spanning over 10 miles. Several slides crossed, blocked, and closed

FREE - Snowpro Plus+ Create High Quality Snow Profiles "Improving Your Profile"

Try Full Featured Snowpro Plus+
for Free until December 31, 2020

- * Works offline for field use
- * Photo attachments
- * Improved Latitude/Longitude entry with Maps
- * JSON Data Format
- * Conforms to CAA OGRS and AAA SWAG Standards, IACS 2008 Symbols

- * Snow and Shear Layer Nicknames
- * 9 Categories of Grain Shape Classifications
Symbols with detailed Grain Shape Sub-classes
- * Implements Flags/Lemons Analysis
- * Computes Snow Pack Average Density, Cumulative Shear Stress, Ramsonde, Snow Loads and more...

Gasman Industries Ltd.

Victoria B.C. Canada
Telephone: +1-250-999-1490
Email: info@gasman.com
Download free version at www.snowproplus.com



SAC: This is one of the two homes that were destroyed by wet slab avalanches west of Ketchum, Idaho. The main tongue of debris was an estimated 40' deep and packed with both live and burned timber well over 18" in diameter. Photo Sawtooth Avalanche Center

roads in and around the Wood River Valley. To the north, the town of Stanley was completely shut off from the outside world as heavy snow and avalanche debris blocked roads in all three directions. Galena Summit was closed for six days, and Highway 21 between Lowman and Stanley remained closed for a staggering 25 days as road crews tackled more than 50 avalanches with debris up to 60' deep.

Through April, we observed over 250 D3-D4 events in our approximately 2000 square mile advisory area. However, it's the relatively few D2s and D3s along the urban interface that will claim their place in local folklore. All told, avalanches impacted 11 structures—including eight homes—and caused upward of \$1 million in damages. According to land surveyor Bruce Smith, an avalanche consultant and 38-year resident of the valley, 2018/2019 was the most destructive urban avalanche season in the last 100 years.

"Am I safe to stay in my house tonight?" "Is it safe to drive out Warm Springs?" This season, I was asked variations of these questions more times than I can count. At the root of the question is a fundamental misunderstanding of the products we issue and our roles as regional backcountry avalanche forecasters. But honestly, who can blame them? We're the "avalanche experts," right?

AVALANCHE WARNINGS are an effective tool for communicating avalanche hazard to the general public who may not check the forecast. Following NAC guidelines, we issue Warnings for widespread HIGH hazard impacting primarily backcountry areas, when avalanches threaten the urban interface, or when both are the case. A disconnect arises when local residents begin to equate every AVALANCHE WARNING with a threat to urban areas. When a Warning issued primarily for a backcountry avalanche problem doesn't produce urban avalanche activity, residents become desensitized to warnings—or they may simply think we're wrong.

At the SAC, we attempt to address this disconnect in a number of ways. First, and most importantly, we're in close contact with local fire, police, emergency, and road crews. Quick discussions to

convey the subtleties of each storm allow these officials to make more informed decisions. Second, we aim to provide timely, rich media content that may be shared by news agencies and local media. Finally, in our forecast product, we often call out particular areas or drainages as examples of where avalanche problems are most likely. When we have the data resolution to do so, acknowledging and identifying patterns at a drainage scale can help our readers better identify areas of greater concern. Walking the tightrope of public expectation and responsibilities as forecasters can be tricky, and we are always looking for ways to improve. What works well for your avalanche center? We'd love to hear from you.

—Ethan Davis



WALLOWA AVALANCHE CENTER

The 2018/2019 winter in Northeast Oregon was highlighted by tremendous snowfall in February. Overall the SWE was well above average, with our Basin Index reporting 157% of the median by mid-April. Our avalanche forecasting began on December 6th and we wrapped up on March 28th, issuing a total of 25 forecasts and 2 avalanche warnings. Throughout the winter we offered 1 forecast a week in December and March and 2 a week in January and February. Our forecasts are supplemented by updates on social media and professional observations on our website.

The season began with very little snow on the ground as December began. In retrospect this was an advantage because we dealt with very few basal problems once we started receiving consistent snowfall. By the end of December, the local Snotel sites were all reporting below average SWE and January didn't prove to be much better. At the end of January, we had a warm snap; temperatures into the 40s left us concerned whether winter was ever going to arrive. February delivered the goods, however, as the Southern Wallawas received near-

ly 18" of SWE and the Schneider Meadows Snotel SWE increased by 48%.

With a mediocre early season and a banner February, we anticipated greater Persistent Slab Problems, but this fear never became reality. Our primary avalanche problems for February were storm slabs and wind slabs. With the constant snowfall in February there was little chance for bed surfaces and weak layers to form. March was also a poor performer in the snowfall category, but fortunately we already had a deep, stable base.

EXTREME AND UNUSUAL EVENTS:

Significant snowfall in February had our forecaster team on high alert. With snowfall down to the valley floor, skiers were able to make turns at lower than average elevations and outside of our forecasting zones. We work closely with the Pendleton NWS office to issue Avalanche Warnings, of which we issued two in February. They do a great job of broadcasting increased danger to the public. Social media and our website also provided good outlets to inform the public of the danger. Fortunately, the increased messaging proved effective and we avoided any reported near misses or fatalities.

The Wallowa Avalanche Center (WAC) became an AIARE provider and we ran a successful Rec Level 1 with 16 students. Northeast Oregon has not had an avalanche education provider aside from our local ski area for the past couple years, but as the backcountry population grows, we felt there was a need for formal education. For 2020 we hope to offer a Level 1, Level 2, and Motorized Level 1.

Along with the AIARE Level 1, we continued to offer free education opportunities, primarily with the Know Before You Go education platform. Our forecasters and volunteers provided avalanche awareness presentations, field training sessions, and clinics to over 264 people. We worked with numerous kids groups, teaching them how to use avalanche transceivers, shovels, and probes. One highlight was working with the local Tollgate Trailfinders snowmobile club and area Search and Rescue teams. We tested the search ability of the avalanche transceiver and how snowmobiles, Snowbikes, and side-by-sides affect the range. As BCA has noted, the electronics interfere with the search range, decreasing range between 50-70% of standard.

We developed a new more user friendly website this season with the assistance of Andy Anderson of the Sierra Avalanche Center. In addition,

WAC: Buried Surface Hoar in the Western Wallawas on Jan. 1st, fortunately this layer was not widespread and didn't become problematic. Photo Victor McNeil



we continue to work with the National Avalanche Center to keep our advisory page and icons current. We also implemented the Remote Weather Station Map, which makes keeping tabs on the weather much easier. Thanks to Scott Havens from Snowbound Solutions for building such a powerful tool. Although we may be a small avalanche center, one of our goals is to keep up with Type 1 Centers in important ways.

We feel very optimistic about our future as a small non-profit avalanche center. Fundraising was again successful this winter, with our first snowmobile specific fundraising event in La Grande with the premiere of Boondockers 15. We also traveled to Portland and had a great event at Hopworks Urban Brewery. The 7th Annual Eastern Oregon Backcountry Festival was again our biggest fundraiser of the year. Over three days, the festival included a showing of the latest Matchstick ski flick, the Kip Rand Memorial Uphill/Downhill race, free avalanche clinics, live music at Anthony Lakes Mountain Resort, and a ski tour into the local backcountry. Mark your calendars for next seasons EOBF, which will take place February 7-9. We thank everyone for their continued support and we hope to offer even greater services in 2020.

—WAC staff



PART 1: “Wind slab. That’s the only one I need to learn about, right? That’s the one I always read in the advisory.” I had a local student ask me this in an avalanche course. It seemed to me that he was joking, but we do forecast a lot of wind slabs here in Central Oregon. This winter was abnormal in that we forecasted persistent slab avalanches more often than in any other year of our brief existence.

Our winter started off slowly and we weren’t skiing until early December (this is late for us), but once things got cranking we had better than average skiing, and a more interesting than average snowpack.

We had three different persistent weak layers that resulted in avalanche activity throughout the year (we rarely experience more than one persistent slab problem each winter). This kept our observer team digging. Our first was a December 8th buried surface hoar layer that remained active until the end of the calendar year with avalanches to size 3. This was followed by a layer of poorly developed near-crust facets on February 1, which would persist until the end of the month when we received 130 cm of snow on the weekend of Feb. 24–26 and a widespread cycle with avalanches to size 3. Lastly, we had another buried surface hoar layer on March 5. The March 5 surface hoar was widespread throughout the terrain, but we never saw avalanches in more than specific locations. This likely kept the public on their toes.

We had two very large wet slab cycles due to rain: The first on January 19 with avalanches to size 3 and the second on April 7 with avalanches to size 4.

—Gabe Color

PART 2: On the operational side of things, COAC had a great year and is continuing to grow. This year marked a milestone as we officially rebranded from

an ‘association’ to a ‘center.’ We wrapped up our 5th season of having a professional observer team and our second season of bi-weekly advisories.

The backcountry community also stepped up engagement with the center’s website and the number of public observation posts nearly doubled over last year for a total of 113 individual public reports. This feels like a great success for us as the local backcountry users see the benefit of having an avalanche center.

In the Fall of 2018, we hosted the first ever Bend-SAW with a sold out crowd of 250+ attendees. The SAW will now be an annual event and we are looking forward to hosting the next SAW on November 9, 2019. We also continued our tradition of the ‘Fresh Tracks’ fall fundraising party, the annual Vert Fest uphill/downhill race at Mt. Bachelor ski area, and free to the public monthly avalanche awareness presentations.

Our long term goal (5 year plan) is to increase fundraising and move from bi-weekly to daily advisories. The local community has been a strong supporter of COAC and we have a lot to look forward to...including ISSW coming to Bend, OR in 2022!

—Aaron Hartz



GNFAC: On January 9th, during a considerable danger two days after multiple days of high avalanche danger, snowmobilers triggered a large avalanche on Lionhead ridge near West Yellowstone (top photo). On February 6th, during considerable danger two days after an avalanche warning, snowmobilers triggered a deeper avalanche on part of the slope that hadn’t slid in January (bottom photo). Both avalanches broke on the same weak layer of facets near the ground. Yellow circles are around the same tree in each image for location reference.



The winter of 2018/19 delivered above average snowfall to southwest Montana, but the delivery was not steady. Weeks of snow were followed by weeks of high pressure. Then more snow, record cold temperatures, and an overall above average snowpack at the end of the season. Weak layer formation was consistently followed by long periods of snowfall, which kept us busy hunting for instability.

Early season snow favored the mountains near Bozeman and Big Sky, while the southern part of our advisory area near West Yellowstone and Cooke City had a much drier start to the season. During early December, southwest Montana was in a prolonged dry spell accompanied by cold temperatures. In the Lionhead area near West Yellowstone a weak layer of facets formed near the ground. In areas where the snowpack was deeper and stronger, the cold calm clear conditions created a layer of near surface facets and/or surface hoar. In mid-December a series of small storms buried these persistent weak layers, and numerous natural and human triggered avalanches were reported across the forecast area.

On December 30th we issued the first avalanche warning of the season after a series of small storms piled on top of buried weak layers. This warning included the southern Madison and Gallatin Ranges, the Lionhead area near West Yellowstone, and the Centennial Range on the border of Montana and Idaho.

This was the first winter we hosted a page on our website to share information relevant to the Centennial Range near Island Park, ID. The previous winter (17-18) there were two motorized user

fatalities in the Centennial Range, which provoked the need for more outreach and information. We collaborated with the National Weather Service in Pocatello, Idaho to issue avalanche warnings for the Centennial Range whenever we issued warnings for the nearby Lionhead Area. The Centennials received abundant snow and several multi-day storms. We had a total of twelve days with avalanche warnings for the Centennial Range, eight were in conjunction with warnings at Lionhead and four were for the Centennials only.

We collaborated with the Sawtooth Avalanche Center and riders in eastern Idaho to offer education opportunities in that region. Near Bozeman and Big Sky, we added a field day specifically for motorized users to our Basic Avalanche Awareness class. We had to increase capacity for this field day and still had a waiting list, so next year we will offer two motorized field days for this course.

On January 25th, a group of four skiers were caught in an avalanche in the Tobacco Root Mountains, 30 miles to the west of the GNFAC forecast area. One skier died from his injuries, one was seriously injured, and two survived uninjured. The slide broke 3-5 feet deep and failed on a layer of well-developed facets formed in December. Steady snowfall for over a week prior to this incident had kept buried weak layers active. After the avalanche fatality, the biggest avalanche cycle of the season occurred across our forecast area with many close calls.

Heavy snow continued through February and favored the mountains in the southern half of our advisory area. During the month of February, SNOTEL sites recorded up to 19" of SWE near West Yellowstone, 12" SWE near Cooke City, and over 6" SWE in the mountains near Bozeman and Big Sky.

At the end of February we had four consecutive days with an avalanche warning for the mountains near Cooke City and West Yellowstone, including the Centennial Range. Snow totals weren't as high in the mountains near Bozeman and Big Sky, but dangerous avalanche conditions existed. On February 26th during a considerable avalanche danger in the Bridger Range, a local skier was tragically killed in an avalanche in Truman Gulch west of Bridger Bowl Ski Area.

During the first week of March a welcome stretch of high pressure consumed the forecast area for nearly three weeks. On March 17th we issued a LOW avalanche danger for the entire forecast area for the first time in nearly two months. This did not last long before above freezing temperatures had a negative impact on stability. By March 20th a wet snow avalanche cycle was underway and the first natural, skier triggered, and rider triggered wet slabs of the season were reported. Temperatures cooled the following week and wet avalanche activity ceased.

During the end of March and start of April, periodic wet storms brought rain in the valleys and snow in the mountains across the advisory area. Avalanche activity was minimal and confined to recent storm snow. We issued our last daily forecast on Sunday, April 7th. Local SNOTEL stations were at 100-120% average SWE for this time of year.

On April 8th, more than an inch of water fell with the snowline around 8,500'. Bridger Bowl Ski Area did not open for their planned closing day due to wet avalanche concerns. Two to three inches of rain fell below 8,000' before temperatures dropped on April 11th and snow fell at all elevations. Below average temperatures and above average precipitation remained the pattern through April.



BTAC: March 4, 2019, snowmobiler fatality, Breccia Pass, which is up off Togwotee Pass, Wyoming. Note from Forecaster Bob Comey: We hiked and did a profile of the crown on the lookers left high flank. Looking at the trees in the runout zone, this path has gone much bigger in the past than it did on this day. Photo courtesy TCSAR

After our last daily forecast, we issued spring weather and snowpack updates on Monday and Friday mornings through April. We found this was an effective and "low-cost" way to stay engaged and share observations and weather forecasts with spring skiers and riders.

We concluded our 29th season after 14 pre-season information bulletins, 129 daily avalanche forecasts, and 8 post-season bulletins. Our Friends group taught 115 classes to 3,275 participants. We had 63 avalanche incidents (aka close calls) reported to us, which were split between skiers/snowboarders (27), motorized users (31) and ice climbers (5). Winter up high persisted well into June, and we hope for a month or two of dry rock and trails before digging into next season's first snow.

—Alex Marienthal, Eric Knoff, and Ian Hoyer



BRIDGER-TETON NATIONAL FOREST AVALANCHE CENTER

During the first half of the 2018/19 season most storms were single day affairs. Snowfall, snow depths, and snow water equivalent totals were below normal. Spells of cold clear nights created

persistent weak layers. Things changed in mid-January as a succession of multi-day storm cycles became the norm. February 2019 was the snowiest February ever recorded and second snowiest month in history in the Teton Range and in the valley of Jackson Hole. Snow depths at the base of the mountains were above record levels from February 24 to March 24. The region experienced below normal precipitation in March, April, and May. Season snowfall totals ranged from 521 to 590 inches at the higher elevation of the Teton Range, barely exceeded 400 inches in the higher elevations of the southern portion of our forecast region, and were less than 400 inches on Togwotee Pass.

Four snowmobilers died in separate avalanche incidents. On December 22, a 31-year-old rider from Wyoming was pinned under his sled after he triggered a small slab avalanche in a concave terrain feature. His riding partner was older and unable to ride or walk through the untracked snow from a groomed trail to provide assistance. The 31-year old died of asphyxia before another group arrived on scene an hour later. This tragic event occurred on a persistent weak layer and emphasizes the potential consequences of being an essentially solo rider.

On January 9, a 29-year old snowmobiler triggered a large slab avalanche on a persistent weak layer and was fully buried without an avalanche



DYNAMIC
AVALANCHE CONSULTING LTD.

Professional Snow Avalanche Expertise



Hazard mapping • Risk assessment • Engineering design • Protection structures
Avalanche safety plans • Worker training • Avalanche forecasting • Risk control

Revelstoke, Whistler, and Kimberley BC
250.837.4466 | info@dynamicavalanche.com | www.dynamicavalanche.com

ALASKA'S WINTER DESTINATION



**SKI & STAY PACKAGES, 1600 ACRES,
7 RESTAURANTS, LIVE MUSIC
BOOK YOUR ALASKAN ADVENTURE
800-880-3880 * ALYESKARESORT.COM**



beacon. This rider was a member of a large group of snowmobilers who traveled to the Togwotee Pass area from Wisconsin. The buried rider triggered the slide from the bottom of a steep slope. The slide was witnessed by two riding partners; however, those partners did not see the rider's location when the slide released. A quick response involving many members of the large group ensued. The searchers spied the handlebars of the buried rider's sled and used probe poles to locate the rider and shovels to excavate their friend from under five feet of avalanche debris. He also died from asphyxia.

On January 25, a group of four experienced local snowmobilers was riding in technically challenging terrain in the Neeley Cove area of the Snake River Range during dangerous conditions. One rider was on his second attempt to exit Neeley Cove on a very steep south facing slope when he triggered a large avalanche that swept him down the hillside and hit his three companions. Those three riders were partially buried, uninjured, and able to self-extricate and initiate a search for their missing companion. As the searchers closed in on the beacon signal of the missing rider they heard the noise of a running sled beneath the avalanche debris. Rider 1 was head down and completely buried in a vertical position near that sled. He died of asphyxia. He had deployed an airbag when he was caught near the top of the slide. After traveling the length of the slide, he and his airbag were completely buried in the avalanche debris. This accident is also believed to have occurred on a persistent weak layer.

The last snowmobile fatality occurred on March 4 on a steep avalanche prone slope in the Breccia Cliff area on Togwotee Pass. This incident

also involved a group of riders who traveled to the area from Wisconsin. This party of four was well prepared with avalanche rescue gear and had avalanche training. A 27-year old male was making a turn in the upper portion of the slide path when he triggered a large slab avalanche with a five-foot-deep crown that failed on a persistent weak layer. He deployed an airbag while he was still in the starting zone and was carried 1,200 feet to the toe of the slide where he and his airbag were fully buried. The other three riders were watching as the event unfolded and were able to locate and recover their companion within six minutes. The reported cause of death was suffocation.

The abundance of snowfall at the lower elevations during the later portion of the season resulted in an extended period when large roof slides were a serious hazard. The roof slide avalanche hazard was mentioned in our avalanche hazard bulletin on a near daily basis (some temperature dependency) from March 17 through April 9. There was significant property damage to vehicles and roofs during this period. On March 11 a 67-year woman was killed while shoveling the roof of a residential building near Casper Mountain in central Wyoming. In the United States six people have died in roof avalanches during the past four seasons.

The Friends of the Bridger-Teton Avalanche Center funded the redesign of the graphic layout of the avalanche center's website and a smart phone friendly display of the avalanche center products. Funding derived from a crowd sourcing effort initiated by the Grand Teton National Park Foundation (GTNPF) led to the purchase and installation of two new automated weather stations near Surprise Lake in Grand Teton Na-

tional Park. The GTNPF also funded a seasonal avalanche technician position in Grand Teton National Park. This position was created and managed by the park for the purpose of improving the avalanche center forecast in the park and in the surrounding areas of the National Forest.

Avalanche education efforts were once again extended to areas in Wyoming outside of the avalanche centers forecast zones. These efforts were possible due to funding that was obtained in partnership with our friends group and the Wyoming State Trails Program.

—Bob Comey



**UTAH
AVALANCHE
CENTER**

The winter of 2018/19 was a fantastic winter for backcountry users in Utah and a welcome relief from the previous year's 2nd driest winter on record. By the end of April, the snowpack was 168% of average across the state with some stations reporting over 200%. This above average snowfall was especially evident in southern Utah where many areas hardly had enough snow to ride the previous season. November to April snowfall at the Alta Guard Station totaled 475". In a winter that refused to quit, powder hounds continued to ride deep powder into May. Colder temperatures allowed mid and low elevations to accumulate more snow than in recent years, allowing for more access and varied terrain opportunities.



UAC: Three snowmobilers near Logan Peak triggered this hard slab six feet deep and 300 feet wide on facets about one foot above the ground. It luckily broke below the three riders, one of whom was stuck and the other two had ridden up to help free him when it broke just as the third rider ascended the slope. Photo Toby Weed

Early season snowfall quickly became weak and faceted at or near the base of the snowpack, with October/November weak layers and mid-December weak layers conspiring to keep backcountry riders on their toes well into the new year. In some cases, these early weak layers avalanched not once but many times—“repeaters”—into January. The snowpack began to stabilize in the central Wasatch Range near the start of February while it remained unstable in other parts of the state. In the La Sal Mountains, these layers roared back to life in late March when a storm produced 32” of snow in 36 hours and resulted in a historic avalanche cycle taking out trees over 80 years old. These suspect layers were the culprit in all of Utah’s avalanche fatalities.

There were four avalanche fatalities this winter following two seasons with no fatalities in the state. This winter’s fatal accidents occurred outside the heavily-used Wasatch Front, and in each case, the parties were missing critical pieces of avalanche rescue gear. For perspective, these four fatalities stack up among 250 reported unintentionally triggered avalanches with 23 riders caught and carried in these events.

In three of the recoveries, the victims were not wearing transceivers. They were located the following day by personnel from local SAR teams, local Sheriff’s Offices, Wasatch Backcountry Rescue, Alta Ski Patrol, Park City Ski Patrol, Brighton Ski Patrol, Snowbird Ski Patrol, Wasatch Powderbird Guides, Utah Department of Transportation, Utah Department of Public Safety, Utah Division of Natural Resources, Manti-La Sal National Forest, and the Utah Avalanche Center. Avalanche mitigation with explosives was performed in each of the three

events. Debris piles were swept by a helicopter with a Long Range Receiver and RECCO unit. Ultimately, avalanche rescue dogs working with probe teams found the victims. The cooperation and coordination among these organizations, most of whom had never worked together, was truly remarkable. The fourth avalanche victim was recovered the day of the accident. His partners were digging very close to his location. When another group arrived with an avalanche probe, they quickly located and uncovered him but it was too late.

Despite these tragic events, many people took advantage of stable conditions in many parts of the state and enjoyed deep powder. It was a successful year for the UAC as well. Notable highlights included:

- UAC received the University of Utah J. Willard Marriott Library’s Ski Archives History Maker Award for our 39 years of avalanche forecasting and education.
- We launched a fully redesigned and mobile-friendly website and an updated iOS app
- Know Before You Go Avalanche Skills eLearning Program launched in November 2018 with over 46,000 course views by April
- We completed the “Off-Piste: Tragedy in the Alps” video for the BRASS Foundation and US Ski and Snowboard. The video has received over 1.2M views since release in September 2018.
- 25th Annual Fall Fundraising Party and 15th Annual Logan Pray for Snow Party as well as our first spring fundraiser which exceeded our fundraising goal and had 59%
- The Utah Legislature passed H.B. 380 designating the first week of December each year as Avalanche Awareness Week

- 33,331 Downloads of UAC Podcast with 13 episodes for Season 2

Avalanche Education was another area of huge success. The UAC delivered on-snow education to 35% more students than last season reaching 876 students with an on-snow class. The KBYG program was presented to 118 groups this season bringing the total participants in Utah since 2004 to about 196,655 people throughout Utah. The total online views of the KBYG video increased to over 753,000 since the fall 2015 release with >55,000 views in the past 12 months. The UAC produced 324 videos receiving over 3.6M views this season. We have begun working with US Ski and Snowboard to create an Avalanche Awareness Training program for their athletes and coaches with a goal release of fall 2019. This program has a potential reach of 40,000 athletes and coaches.

We continue to receive amazing financial support from the backcountry community, local businesses, and state and federal programs. Without all of this support, the UAC would not be able to provide the forecasting, awareness, and education programs that the community relies on. Thank you to everyone who provided support this season.

—Mark Staples



**MOUNT SHASTA
AVALANCHE
CENTER**

At last the Mount Shasta area and its kooky contingent of fanatical snow slayers received the winter

dreamed about. “Below average” is a phrase that has become increasingly common in post winter precipitation stats. “We’re thinking about moving...”, an eavesdropped grumbling at a local BBQ. Yes, we have that gorgeous 14,179-foot pile of glaciated snow, rock, and ice in the background, keeping us calm even on low snow years, but missed are the rumbling plows, icy roads, towering snow berms... you know, a good old-fashioned WINTER.

That all changed for us this past season. Sliders and riders were out by late November, enjoying early season storms that left enough snow for a few touchy turns. December was nothing spectacular, but incremental storms continued to build the winter snowpack. We had a joyous white Christmas and by the end of the month, a solid base covered most hard and sharp objects. And then there was the rest of the winter.

Nearly constant storms battered Northern California for February and March. It. Was. Awesome. For recreationalists and forecasters alike, it was a winter full of powder in the face, huge avalanches, frozen fingers... a winter of winters past. The 30+ foot snow banks at the local Bunny Flat trailhead were a tourist attraction in and of themselves.

The winter was typified by large, eyebrow raising storms and avalanche events. The most notable and widely heard about avalanche for the season was the giant Valentine’s Day Avalanche in Avalanche Gulch, on the south side of Mount Shasta. A very large (R4/D4) natural avalanche released from near 12,000 feet in the upper ramparts of the drainage and terminated at 7,200 feet down Avalanche Gulch proper. This slide ran over three miles and approximately 5,000 vertical feet. The toe of the debris was 30-60 feet high. The main avalanche caused sympathetic release of other slopes in its path. Trees had glacial-like scouring and were buried by debris (photo). The crown of the avalanche was never seen unfortunately. A heavy hitting winter storm brought 5.84 inches of SWE with reasonable snow levels and was im-



SHASTA: This was the large slide that occurred on the east side of Mount Shasta, in a location obscured from most eyes. It was as large as or larger than the Avalanche Gulch event. This slide path had fewer constrictions than Avalanche Gulch slide path.
Photo S. Irvine

mediately followed by a rapid warming. Visibility was junk, road access was shut. By the time the skies cleared, all that was left were the track and debris piles. While the mountain has certainly produced larger avalanches in the past, it’s the biggest in recent history and we may have fewer opportunities to experience something of this magnitude in the future. It was quite impressive from every measure: length, width, height of the walls, debris pile. We certainly feel a sense of scarcity around these events within the current climate.

A very similar avalanche in all regards occurred weeks later in the season over on the east side of the mountain. A 12-day period of nearly constant precipitation (8.29” SWE) resulted in another huge D4 that was equally impressive as the Valentine Avalanche but received very little attention due to its more obscure location. Both avalanches started as slabs, though appeared more like loose-wet slides by the time they came to rest at lower elevations where snow qualities were much wetter. In other parts of the forecast area over the winter, additional large slides expanded avalanche paths. This was all very exciting for us working at the avalanche center. We’ve jokingly questioned whether our existence is even necessary over the past few dismal winters. By season’s end, total snowfall at 8,000 feet on the mountain soared to 35 feet. This ensured a stellar spring climbing season and left most snow recreationists thoroughly satiated.

The center’s outreach and education continued with all normal offerings with a few additional presentations. Outreach included a presentation at the California Avalanche Workshop, once a month local avalanche awareness (AA) talks and companion rescue (CR) clinics, a motorized AA/CR workshop, numerous kids AA sessions and several other AA presentations to Southern Oregon University students, nearby snowmobile clubs, USFS snow survey crews, and regional REI stores.

The Friends of the MSAC is thriving. Numbers are up across the board. They have a couple of fresh board members. The board is a motivated and positive set of folks that pour their heart and soul into the avalanche center and community. They are patient with the Forest Service. Everyone gets along. It’s quite nice. Fundraising events hosted by the group include movie nights, guest speaker slideshows, the rapidly growing Shasta Ascension Backcountry Race, and the annual Snowball party...a raging good time. Respectively, record attendance and dollar amounts were set for the Ascension ski race and Snowball events.

Each year since 2012, the MSAC has received a California State OHV grant. This has helped fund operations of the center tremendously. Forecaster equipment, snowmobiles, education materials, and salaries have been aided by this money. The MSAC, for the third year in a row, employs three forecasters. Nick Meyers has been a climbing ranger on Mount Shasta since 2002 and the Lead Ranger/Director of the MSAC since 2010. We were sad to see Andrew Kiefer jump ship this past year, but excited for him to push his career and social life by getting on-board with the Northwest Avalanche Center out of Bellingham, Washington. Ryan Sorenson, a former Shasta Mountain Guide, stepped into Andrew’s footsteps for his rookie year with the center and as a mountain ranger. Fun fact: Ryan climbed Mount Shasta in 1 hour 39 minutes in 2015, right up there with the top three fastest times known. The current speed record is 1 hour 37 minutes. Aaron Beverly, a Friends em-

ployee who can climb the mountain in about 6 hours, completed his third year of work with the center. Aaron consistently provides a solid set of skills and a sharp mind. Aside from Aaron’s great forecasts and improving snowmobile moves, most notable and essential to the avalanche center are his webmaster talents. He serves as the main webmaster for the MSAC and we’re super thankful for this. Aaron has also taken to weather station troubleshooting and has a real knack for it. Maybe his master’s degree in electrical engineering is helping. All employees of the MSAC also function as snow rangers, trailhead snow removal technicians, and professional frozen toilet scrubbers.

The picture painted above would indicate all things are hunky dory at the MSAC, but the center has an Achilles heels too. Like many avalanche centers, the MSAC relies upon grant funding and fundraising to operate at its current staffing level. Minus grant monies, staffing changes and/or alternative funding would have to be implemented. Though with annual, dedicated Forest Service dollars and stronger than ever community and Friends support, confidence is high for the MSAC to continue at its current level of operation for years to come.

—Nick Meyers



TAHOE
NATIONAL
FOREST SIERRA
AVALANCHE
CENTER

CONSISTENT STORMS, DEEP SNOWPACK, AND A DELAYED SPRING

Our forecast season began with the ending of a long, dry, and warm fall in California. Winter started at the end of November with a storm that provided enough snow for some backcountry travel options. Storms were scattered through December with two large storms during January with overall mild temperatures. One of the few persistent issues for the year was a facet/crust combination that developed over the holidays. This was subsequently buried during the Jan 5-7 storm cycle that deposited 3 to 4’ of snow. Several days after the storm cycle, with no other avalanche activity reported on the facet/crust layer, a large unintentional cornice collapse released a deep slab avalanche with a 4-8’ crown line on the north side of Castle Peak. This avalanche was 200’ wide and ran 800’ full path. It occurred on a sunny and busy weekend in the backcountry with multiple different user groups in the area, but somehow no one was involved.

February will be remembered and talked about throughout our backcountry community for years to come. The month had well below average temperatures and measurable snow for almost every day of the month. At times, temperatures were 10 to 20 degrees below average with continued storm activity that averaged over 8”/day for the entire month, creating a well bonded mid-winter snowpack, with 10-15’ of new snow with no known persistent weak layers. Even with the abundance of snowfall, avalanche activity was limited to wind slabs and storm slabs with most being D2 in size or smaller. The month of February set records in many areas for the most snowfall ever recorded in a single month. Even hard-core locals were dreaming of sunny spring days and complaining of lower back pain from too much



TSAC: Commuting to work. Just another snowy day in the Sierra, winter 2018/2019. Photo Steve Reynaud

shoveling. Local health food stores sold out of Vitamin D supplements and light therapy lamps. March continued with consistent snowfall right into mid-April. We rarely had a break between storms that lasted more than three days before another storm came in. Our well-known spring skiing corn cycles did not fully establish with limited days of good spring skiing until mid-April. Winter ended at 150-200% of normal depending on location. Most neighborhoods around the greater Lake Tahoe area began to melt out in late April; a deep snowpack still existed in the mountains with skiable snow lasted into the summer months.

During the 2018/2019 season from November 29th through April 21st, the Sierra Avalanche Center issued 145 daily avalanche advisories. The number of advisories issued for each danger level was: 26 Low, 84 Moderate, 19 Considerable, 16 High, and 0 Extreme. Additionally, 2=two early season snow condition reports were posted during November. TNF/SAC forecasters and pro observers collected 268 backcountry snowpack and avalanche observations this past season. These were supplemented by an additional 53 backcountry snowpack and avalanche observations submitted by the local guide services and 253 observations from the general public. 21 avalanche incidents were reported this year with no avalanche fatalities. Two of these incidents involved long time locals with serious life-threatening injuries that required helicopter evacuations.

Operations at the Sierra Avalanche Center this past winter remained consistent with previous years. Director/lead forecaster Brandon Schwartz along with Andy Anderson and Steve Reynaud served as avalanche forecasters. Travis Feist and David Reichel continued as professional observers for the southern half of the forecast region.

The Sierra Avalanche Center functions as a partnership between the Tahoe National Forest and a volunteer Board of Directors with 501(c)(3) non-profit organization status. Mark O'Geen continued as Executive Director for his second term along with Mark Bunge as SAC Board President. The SAC board remains a tight knit organization that continues to thrive with momentum and financial successes. SAC continues their ongoing scholarship program to help offer avalanche education for our local user groups. Professional observer David Reichel has added on a new position as social media coordinator managing our messaging and communication. Professional observer Travis Feist remains as education coordinator focusing

on our backcountry and snowmobile avalanche outreach programs. Our programs continue to grow through the continued funding from a CA OHV grant. SAC's snowmobile avalanche education program ran six snowmobile specific Level 1 avalanche courses throughout our forecast region. The non-profit SAC and the Tahoe National Forest continue to work together to provide funding and operational support for the avalanche center. Working together, we continue to be a growing and expanding avalanche center providing avalanche forecasting, education, and outreach to our central Sierra Nevada community.

—Steve Reynaud



EASTERN SIERRA AVALANCHE CENTER

The 2018/2019 season marks the Eastern Sierra Avalanche Center's (ESAC) 13th season serving the Eastern Sierra backcountry community. This winter season proved to be a massive one, with the snowiest February on record with over 200" of snowfall. For the second year, ESAC operated as a Type 1 center, issuing daily Avalanche Advisories for the majority of the season, and for the first season ever issued Backcountry Avalanche Warnings in cooperation with the National Weather Service and the National Avalanche Center.

ESAC began its winter in earnest on December 1st by published its first Avalanche Advisory of the season in conjunction with its popular full-day annual Season Kick-Off event. Well-timed with fresh snowfall, the day began with a wide range of free daytime clinics for the public and culminated with a packed-to-capacity evening fundraiser featuring Tahoe-based professional free-skier Michelle Parker. The event drew over 300 people and raised over \$17,000. Local businesses, artists, gear companies, and community members all gave enormous contributions to make the event a huge success. The excitement brewed at this event hardly fizzled out, as Mother Nature would cooperate fully in providing a jam-packed season of intense weather and snowfall. ESAC was very happy to have three full-time forecasters to take the season on.

This season's snowpack formation got a relatively late start with mountain slopes bare to the ground until the first real storm on Thanksgiving which dropped 1-1.5ft of heavy dense snow, followed by another solid dump of 2-3ft a week later. December was a relatively meager month with a handful of small storms, but increased winds between these storms led to the most severe avalanche related injury of the season when an in-bounds skier at Mammoth triggered a fresh wind slab. This avalanche ended up hitting a woman traversing below on the slope and hospitalized her with internal injuries. This event foreshadowed the most common conditions that led to many of the human triggered avalanches this season – relatively small amounts of new snow followed by windy conditions.

After a somewhat disappointing month of December, January turned back on and brought the snowpack back up to average, but not before presenting a concerning Persistent Slab problem, which is rare for our mountains. Several eye-opening avalanches were triggered at low elevations on buried weak layers that led many to reconsider their typical "safe skiing" terrain. Luckily no one was caught or injured. Then came February which changed everything.

Back-to-back Atmospheric Rivers brought virtually non-stop winter storms leading to the wettest February on record with over 200" of snowfall. Two separate Backcountry Avalanche Warnings were issued that month spanning a total of 7 days. Widespread natural avalanche cycles took place, but the harsh weather kept people *for the most part* from getting in harm's way. That being said, a concerning ice crust developed from a high elevation rain event over Valentine's Day, which resulted in at least one incident.

The first week of March kept pace with February, but the rest of the month scaled back to intermittent small storms. However, continued winds kept the avalanche danger at MODERATE for shallow wind slabs for most of the month. Despite these winds, the allure of much-missed sunshine resulted in quite a few people pushing into more consequential terrain, and a surprisingly large number of human-triggered avalanches resulted. Fortunately no serious injuries resulted despite some harrowing rides.

As of mid-April, study plots recorded 460" of snow at 9,000', and snow scientists from the University of Colorado estimate that the snowpack in the Southern Sierra is over 200% of its mid-April average. April was a beautiful month of sunshine,

NASA images of the Eastern Sierra mid-Feb snowpack, 2018 on the left vs. 2019 on the right.





ESAC: The discovery of this 3ft crown at dusk on January 18th led people to reconsider their typical "safe" skiing terrain. The crown extended for nearly 1,500' through mature forest falling on buried facets (HS-N-R4-D2.5-O). Photo John Wentworth

above average warm temperatures, and big corn-turn smiles. One to two light spring showers a week however kept high elevation slopes transitional and the concern over Loose-Wet avalanches very real. Timing continued to be everything as more than a few loose-wet slides shook people up and kept them on their toes.

As the saying goes: "April showers brings May \$#@& ?!" Flowers were certainly beautiful in the valleys in May, but up high in the mountains May was a return to winter! Three storms in mid-May each dumped over a foot of snow in different areas of the forecast area, and short-lived fresh wind slabs were being triggered. Fortunately there were no reports of anyone caught! The image of the snowflake on NOAA's forecast virtually everyday for the last 2 weeks of May left people asking, "will summer ever arrive?"

Through the course of the winter, ESAC forecasters posted 87 Avalanche Advisories with

Danger Ratings during the months of January, February, and March and another 36 multiday Avalanche Advisories during the months of December and April. Over 460 Snowpack and Avalanche Observations were submitted on the ESAC website, and 8 incidents were reported where skiers or boarders were caught in avalanches.

As of the publishing of this report on May 21st ESAC is extremely pleased to say there were no avalanche fatalities in the Eastern Sierra during the 2018/2019 season.

—Josh Feinberg



BRIDGEPORT AVALANCHE CENTER

An early Thanksgiving storm delivered the first snow to the Eastern Sierra and set the trend for the rest of the 2018/2019 winter season. This early storm required the Bridgeport Avalanche Center (BAC) crew to play catch-up when they started in early December to ensure installation of infrastructure was completed before the Bridgeport Winter Recreation Area (BWRA) on the Humboldt-Toiyabe National Forest's Bridgeport Ranger District opened to winter recreationists. Snowmobilers hit it hard from the start as snowline was below 7000 feet at the California State Route 108 trailhead when the area opened on Dec. 15, 2018.

When it continued snowing through January, February, and March, the BAC crew kept diligent attention to the weather variables and how the pack was shaping up. After each snowy deluge and several atmospheric rivers (AR), the slab

avalanche activity would ramp up then back-off into a relatively stable pattern after shedding. The area had several historic size avalanches that even removed some old growth trees in their path, creating an even wider corridor in the Repeat Offender and Lil' Buddy slide paths.

One particular weather event on Valentine's Day brought rain to nearly 10,000 feet and caused catastrophic large wet slab avalanches.

From that day's forecast:

"We are enduring a pretty amazing atmospheric river (AR) weather event. As described in the name, a less cold moisture rich plume of vapor is slamming into the mountains of the Sierra. Starting near the equator, this violent storm system carries with it strong winds, lightning & less-predictable weather. An unusually strong wind phenomenon called a "sting jet" has been noted in weather models, equaling severe damaging winds. The mixing zone of snow & rain will rise to near treeline today. Take into account there is a lot of snow in the below treeline zone & the potential is there for large sized Wet Slab avalanches with the addition of rain weight. Dry snow is capable of holding substantial water weight before it fails in shear strength."

Even in May this layer was distinguishable in most rotary plow cut-banks along roadways.

The BWRA saw a record number of permitted users, days in operation, avalanche/snowpack observations (77), and snowpack summaries (52). Joe Soccio, Andy Farrell, and Ryan Lewthwaite made up the BAC crew and were able to disseminate avalanche information to patrons nearly seven days a week. Soccio and Farrell manned the observation and ground operations side, while Lead Forecaster Lewthwaite was able to produce three snowpack summaries weekly. Also this winter, Soccio and Farrell became expert backcountry snowmobilers and attended the Motorized Level 1 Avalanche Classes held by the Sierra Avalanche Center in Lake Tahoe, California. Lewthwaite completed the American Institute for Avalanche Research and Education (AIARE) Pro 2 Course in Stanley, Idaho.

As a part of the BAC's avalanche education component, the team hosted three two-day snowmobile-specific avalanche awareness classes. One of the highlights was when a family had their seven-year-old son participate in the rescue scenario. In an amazing fashion, the boy finished his fine beacon search and began strategically hand-digging while his father assembled the probe and shovel.

The BAC had an overwhelmingly successful season with no injuries or major mechanical malfunctions. The team continues to make improvements to the avalanche center and how they provide relevant input to the motorized avalanche community. Last season, the BAC was included on the National Avalanche Center's website (Avalanche.org).

The BAC crew looks forward to the 2019/2020 winter season as they work to expand their product to more terrain and provide even better service to the recreationists who enjoy the BWRA.

—Ryan Lewthwaite



BAC: Ryan clearing the snow stake at the snow study plot near the Sonora Pass SNOTEL site. Photo Joe Soccio



KPAC: Derik Spice at crown fracture from Snowslide Canyon avalanche taken on Feb 8. Photo Troy Marino



**KACHINA
PEAKS
AVALANCHE
CENTER**

FOCUSED TOPIC: Finally, we were blessed with a winter in Arizona. By season's end we recorded 344 inches of snowfall, 132% of our winter average. According to Arizona Snowbowl records, this was the fourth wettest winter in the last two decades.

After a bit of a slow start in the fall, new snow became a regular occurrence. From mid-January to the end of March, precipitation was consistent with only two dry weeks without new snow. Our biggest event occurred on February 21 and 22 when we received near record snowfall with a storm total of 67 inches at our 10,800' study plot. Flagstaff Airport broke an all-time 24-hour record with 40 inches on February 21. Surprisingly few



KPAC: Cornices on the ridge between Abineau and Rees Peaks taken March 29. Photo Troy Marino

avalanches were reported after this major storm, although post frontal wind out of the northwest on February 23 built impressive cornices on ridgetops, a rare feature for us. Throughout the winter, we observed several natural avalanche cycles. The most pronounced of these was a major event in Snowslide Bowl on the east face of Agassiz Peak on February 5 or 6 (HS N R4 D4). This slide had a crown thickness of 1-1.75 meters, a starting zone width of 300 m, and a track length of 1100 meters; and it ran on early season basal facets (*see photo above*).

Thankfully, no fatalities or even human avalanche burials were reported this season. We published 25 snowpack summaries from December 1 through April 18, with approximately 40% warning of potentially hazardous avalanche conditions. We do not publish an avalanche danger rating in the summaries. In addition to our regular weekly advisories, we published four supplemental storm updates.

Avalanche Education: Despite canceling an early season level 1 course due to insufficient snow coverage, we broke our previous record of level 1 course participants, by serving a total of 60 individuals. We offered 28 partial tuition scholarships, of which 16 were utilized. Our goal is to reduce the financial burden for everyone who needs backcountry education, but cannot swallow the price tag. Our ninth annual Mikee Linville Scholarship Fundraiser was held on March 20 and successfully replenished our restricted scholarship fund for next year. This program has really made a difference in raising awareness in our local winter backcountry community and presumably prevented accidents due to ignorance. We also offered several free avalanche awareness workshops at local sporting goods stores, and at the Coconino County Sherriff's Leaf Auditorium, as well as, our usual appearance at Flagstaff Festival for Science—Science in the Park event.

We were awarded a RAC grant this year which involved field work with a snowpack hydrology focus. These funds helped to support snowpack stability evaluations as well, significantly increasing data quality upon which our snowpack summaries were based. We anticipate continuing with this project next winter and hopefully into the future.

Given the productive snowfall, the number of winter backcountry permits issued by Coconino

National Forest was only 795, down significantly from the 2009-10 season when over 1100 permits were issued. These permits are a free service provided to encourage winter preparedness in avalanche terrain. The federal government's sabbatical between December 22, 2018 and January 25, 2019 may have reduced compliance with this requirement, since there were no volunteers or employees available to issue the permit during the early season.

Website use: This was our biggest season yet for website visits!

—KPAC staff



**CRESTED
BUTTE
AVALANCHE
CENTER**

When you get a winter full of storm on storm action, then you are setting up for some historic and/or unusual avalanches. Put down those peanuts because this was one to remember.

The snowpack got a classic Continental start. Around October 10th the first storms rolled in and plastered the alpine with a couple feet of snow. Then, as you would guess, the rest of October was dry. Early November had another round of storms with some of the first skier triggered avalanches reported. Mid November had another lengthy dry spell, then late November it all changed as consistent snowfall with generally short breaks between storms lasted until we reached peak snowpack depth on April 6th.

All hell broke out in March. If your name was "Snowpack," at this point you were strong enough to play with a couple of sumo wrestlers, but an unrelenting stream of them jumping on your back? You're going to give out, creating historic avalanches in March, after a 10-day storm period that ranked 3rd in the major storms recorded on the Schofield Snotel since 1986.

So what were the forecasting challenges this winter?

Our answer is two-fold:

- forecasting for avalanches in unusual places
- and getting our message out to more than just the backcountry recreationalist.

To start, the CBAC's connection with the community is pretty special. We are a non-profit avalanche center that supports a team of forecasters (Eric Murrow, Evan Ross, Ian Havlick, Steve Banks), and operates almost entirely from money donated by this community, with no federal or state financial support. The community donates the money and with that support we deliver them a high-quality product. This last winter we delivered 150 weather and avalanche advisories; 161 professional snow and avalanche observations; a platform to display the further 310 public observations; weekly summaries of the weather, snow, and avalanche activity; YouTube videos; social media posts; and a host of free beacon clinics and avalanche awareness talks.

People seem to notice red and black danger warnings of dangerous avalanche conditions in the backcountry, we have observed the vast majority of skiers choosing to shred the ski area and avoid the backcountry. They might not realize, however,



CBAC: (Top) The Green Lake Fish Smasher ran during the first week of December, displacing fish in the lake the day before this photo was taken. Note the water that was pushed out of the lake and sent cascading down the cliffs below! Photo Billy Rankin

(Bottom) This roof avalanche caught and buried a person on March 8, 2019, in Mount Crested Butte. The avalanche came off the roof in the upper right, and the person was buried near the shovel on the left. Photo Ben Pritchett

that the same dangerous avalanche conditions can be found in unusual or unexpected places such as the small slopes around town where kids like to sled, urban slopes that don't typically hold a snowpack capable of avalanching, or the overhanging dangers of roof avalanches. With this past big winter, we were concerned that these areas exposed a greater percentage of people to dangerous avalanche conditions, so we mounted a campaign to raise awareness of these unfamiliar hazards.

How did the CBAC do on those topics?

SMALL SLOPES AROUND TOWN:

We worked with town officials to either close roads around town, and/or post signage on roads

and sledding hills when we were issuing a HIGH avalanche danger rating. It's the last two topics, slopes that don't typically hold a snowpack capable of avalanching and roof avalanches, that proved deadly this past winter.

SLOPES THAT DON'T TYPICALLY HOLD A SNOWPACK CAPABLE OF AVALANCHING:

On February 16th, two backcountry skiers were killed in an avalanche on a commonly traveled route to the Friends Hut in the Brush Creek Drainage. A section of this route traverses a steep SE facing slope at an elevation of 9350ft. This slope doesn't often hold a snowpack capable of avalanching due to both its low elevation and as-

pect to the sun. With this past winter's well above average snowfall, and short breaks between storms, conditions were different. The CBAC used wording many times in its daily avalanche summaries attempting to make backcountry travelers aware of the potential threat of avalanches where they don't typically see or expect them. On February 16th, a Special Avalanche Advisory was issued in coordination with the CAIC, and summed up the general dangerous conditions, while the CBAC forecast summary added some more specific wording about easier to trigger avalanches near and east of Crested Butte in the typically drier portions of our forecast area that included this Brush Creek site.

ROOF AVALANCHES:

On March 6th and in the middle of the huge March Storm, when everything was already fat, we saw warm temps and some rain up to about 10,000ft as the next Atmospheric River event rolled in. Many roof avalanches released around this time and over the next couple days as temperatures stayed relatively warm under southwest flow. On March 8th a man was buried for around 2.5 hours after a roof avalanched above him. He credited his survival to Tupac's Greatest Hits playing on his earphones, an air pocket, and his wife and rescuers that dug him out. On March 9th two people were clearing a roof when it avalanched and buried them both. They were dug out in 20-30min, one man survived and one passed away during that time.

The CBAC will continue striving to make connections with the local community and beyond. Helping our networks to be pre-established and allow us to inform more than your everyday backcountry user when avalanche conditions are dangerous in unusual places.

—Evan Ross



The 2018/19 avalanche season in Colorado was one for the history books, and gave us enough material to talk about as we get old(er) and crusty(er), telling stories to the next generation of snow lovers about the good 'ol days. Avalanches hit roads, buildings, power and gas lines, and created new avalanche paths (or at least reshaped old ones). People were caught in avalanches while hiking, snowshoeing, cat skiing, in an avalanche course, shoveling their roofs and sidewalks, while driving, at work, and just sleeping in their beds.

Our season started early with snow in mid-October. Big storm events around the holidays led to some exciting avalanche cycles. By the end of February most of the avalanches were running at or just below the storm snow and the snowpack in most of the state was around 120% of the 30-year median. Then came March and an historic avalanche cycle that produced events and outcomes that not even the old timers had seen before. Considering this followed a historically dry season in Colorado, it had us wondering yet again about the future. Are these wild variations with events outside of our historical memory going to be the new normal?

There were a little under 4300 avalanches reported to the Colorado Avalanche Information Center (CAIC), but we are adding to this tally as we come across more evidence of very large avalanches throughout the summer. During the 2018/2019 avalanche season we documented 92 incidents, with 136 people caught in avalanches. Eight people were killed, which is above the 10-year average of six avalanche deaths. The number of involvements far exceeds what we recorded in recent years. There were at least 34 people caught in January and 36 in March alone. For comparison, we recorded an average of 48 incidents and 66 people caught in avalanches per season going back to 2011.

October storms dropped enough snow at higher elevations to persist and lure anxious souls into the early-season snowpack. Our first incident of the season occurred October 12, when a backcountry skier was caught in a small wind slab avalanche near Loveland Pass. A few days later on October 15, a hiker was caught, carried, and seriously injured in the Front Range when a small avalanche carried him over two cliffs and through thinly covered rocky slopes. Despite serious lower-body injuries, the hiker was able to self-evacuate, avoiding a potentially tragic outcome.

November started with a series of small storms and an uptick in avalanche activity. There were a few people caught in the first week, including an on-duty ski patroller, but fortunately no injuries. Then we saw one of our more prolonged dry spells as a ridge of high pressure kept Colorado largely out of the storm track through the middle of the month. As Thanksgiving approached, snow returned with back-to-back storms that brought the permanent onset of winter. A series of storms from November 22 to 28 brought fairly dense snow to most mountain ranges, and we saw another series of avalanche involvements, including a full burial of a ski guide near Aspen. A quick rescue response from his partner allowed the guide to walk away with only minor injuries.

December started out fairly snowy, favoring the Central and Southern Mountains with modest loading events and a cycle of small avalanche activity. The middle of the month was once again dry, and as the Christmas holiday approached, a period of steady snowfall began and lasted until the New Year. These “Christmas storms” came in dense, with moderate to high precipitation intensity, and another avalanche cycle began in late December. This was the most significant avalanche cycle of the season up to that point. Our deeper snowpack areas started to show signs of things to come, as the snowpack gradually became stronger and deeper. Sixteen people were caught in avalanches in December, including an incident that caught three people working for a mechanized ski operation, but we ended 2018 with zero avalanche fatalities— a promising run that did not last.

The start of 2019 brought the onset of consistent snowfall to most areas, with only short-lived dry spells separating large storm events nearly every week. We saw a series of accidents and close calls during the first week of the new year, and the first avalanche fatality of the season on January 6 when six people in an avalanche course were caught, and one person was buried and killed. Another series of storms the following week led to several partial and full burials, and the second fatal accident on January 21 when a backcountry skier was killed skiing out of a hut near Aspen.



CAIC: Avalanche debris covering County Road 2 outside of Silverton. Photo Jason Ebelheiser

The stormy pattern continued into February, with major storm events about every week. Our snowpack really began to climb above the long-term median as these storms dropped feet of snow and inches of water. Weak layers near the ground were becoming less of a concern in many deeper areas, but avalanches breaking on mid-pack weak layers were still a threat. A storm right around Valentine’s Day caused dangerous avalanche conditions, and on February 16 two skiers training for the Grand Traverse ski race were buried and killed in a small avalanche on a short steep slope above a creek. This was a tragic reminder that terrain traps kill. On February 19, a solo skier out for some exercise on a valley floor trail outside of Telluride was killed when he was buried by an avalanche triggered by a party above him. This was a sobering illustration of the increasing risk of other parties recreating around and above people in the backcountry.

Then came March, and boy did it come in like a lion. We are still wrapping our heads around the magnitude of what happened during the first two weeks. In our deeper snowpack areas, we had not seen avalanches breaking on deep weak layers for some time and thought they might be done for the season without massive loading events. When the massive loading events came, we saw the kind of avalanche cycle these mountains are capable of producing.

From February 28 through March 5, we picked up between 2 and 5 feet of snow and 2 to 4.5 inches of water across most mountain areas. We started to see D3 and D4 avalanches on the night of March 3, from Gothic to Red Mountain Pass. This closed down US 550, which wouldn’t open again for 18 days. On March 4, D4 avalanches were running into cabins and filling creek bottoms. We started to see things run that hadn’t run that big since the 1950s and 60s, beginning to create new avalanche paths and wipe out big swaths of mature timber. High-profile avalanches were crossing I-70, catching moving vehicles, and making western Colorado a remote destination. But it didn’t stop there.

Storms continued on March 6, and by March 7 totals achieved 9 to 10 feet of snow. More avalanches were hitting highways and destroying

power lines. On March 7, half the state sat at Extreme danger, and even valley floors and thick timber provided no safe refuge. Sadly, a guide for cat ski operation was killed on March 7 from a very large avalanche likely triggered by cornice fall from above. Three cars were buried in an avalanche on Colorado Highway 91 outside of Copper Mountain. There was no previous record of an avalanche in this path reaching the highway and the slide ran through 1100 ft of mature timber before hitting the road. On March 8, a person shoveling a sidewalk near Crested Butte was buried for two hours in a roof avalanche, but miraculously survived. The next day two workers in the same area were caught and buried in an avalanche while clearing a roof, and unfortunately one of them perished. D4 avalanches were widespread and the biggest releases were pushing into the D5 category. More houses and cabins were hit and some completely destroyed, and yet we were not done yet. By March 12 areas in Hindsdale County near Lake City were falling apart. As just one example, the Sheriff’s home was hit and completely destroyed while he and his two daughters lay sleeping in bed— another miraculous outcome when all three survived with no major physical injuries. People evacuated suspect buildings and locations and a state of emergency was declared. Things began to finally slow down after March 12 with only a few more D4 avalanche trickling in after that.

In (partial) summary, the March cycle:

- Dropped between 10 and 15 feet of snow in 10 days
- Deposited between 6 and 12 inches of water in 10 days
- Killed two people; one mechanized skiing and one roof avalanche
- One critical injury in a roof avalanche
- Damaged or destroyed at least 4 houses/structures
- Damaged at least 4 cabins
- Damaged gas lines, power lines and towers
- Damaged Gazex infrastructure
- Closed US 550 for over 18 days

It was all hands on deck, and nobody at the CAIC slept more than a few hours at time for at least the first 10 days of March. The cycle produced some of the largest avalanches we’ve ever



CAIC: Massive D5 avalanche in Conundrum Creek that ran March 9. Everything on the right side of the photo ran in a single event, putting around 200 feet of debris in the creek. The avalanche ran up the opposing hillside before turning down valley, and took out thousands of trees. The home in the center of the photo was protected by an engineered splitting wedge. The home sustained some damage but the wedge saved it from destruction.
Photo Brandon Huttenlocher

seen, across most of Colorado's mountains, all in the same cycle.

Winter continued into April and through May but mercifully calmed down. We had more incidents, especially as people pushed into steep consequential terrain with cold storms going through most of May. The continued snowfall pushed some SNOTEL sites to over 1000% of the long-term median by the end of May and into June. Corn snow finally arrived in June as we published our last avalanche forecast and began to pick up the pieces left by the 2018/19 season.

—Brian Lazar



Winter arrived early and stayed late this season in New England. Snow began to fly in mid-October and soon a 15" storm followed by a week of additional relentless storms dropped 52" of snow by the time November began. Of course, none of this was going according to plan since this was the year we planned to begin forecasting for the entire Presidential Range and we weren't ready yet! Skier triggered pockets of wind slab in Tuckerman's Left Gully in mid-October reminded us that we weren't in charge of the weather. We issued five general bulletins starting on October 27th which bought us some time to develop new web products, new to us anyway.

More snow, record low temperatures through the month (5.2F below average) and a looming Nor'easter in late November led to our first 5-scale advisory on November 27th. Continued cool weather in December preserved the snow and skiers were treated to a rare stretch of soft snow conditions, until the winter solstice arrived, and with it, over 2" of rain. Rain on snow events were a theme throughout the season with copious snow, record setting periods of wind, along with storms that arrived on wind speeds low enough to have a soft, storm slab avalanche cycle or two. Average temperatures were below average during six of the past eight months, but every month saw

the mercury swing well above freezing. The ice crusts from rain, sleet, and ZR events contributed to conditions that led to two fatalities which were the first since a solo climber was swept from Pinnacle Gully Mar 1, 2013 and brought our winter conditions fatality total to 71 since 1928, a figure that includes 15 avalanche related fatalities.

Since the 1930s, skiers have flocked to the wind loaded slopes of Tuckerman Ravine to enjoy spring corn skiing and the John Sherburne Ski Trail, a two-mile, 2,000' vertical ski trail cut by the CCC in 1934 that provides good skiing back to their car in Pinkham Notch. The past decade our snow ranger team has witnessed a steady change in use from intense pressure on late spring, isothermal snowpack weekends when up to 4,000 people may cram themselves into Tuckerman Ravine to far fewer big weekend days in the spring but a significant uptick in mid-winter use in a dynamic snowpack. Skiers in our region are buying AT gear, taking avalanche classes, joining non-profit glade-cutting efforts like the Granite Backcountry Alliance, and seeking out wind-sheltered powder snow. Our forecast product and state and federally mandated search and rescue efforts are evolving to meet this change in use.

Until last year, the concentrated use and high degree of spatial variability due to extreme west to east winds, led to the development and continued use of micro-scale forecasts for 18 small forecast zones, plus two more zones for their intersecting runouts in Tuckerman and Huntington Ravine. Now at 116 square miles instead of the previous two square miles of forecast area, our expanded zones have allowed us to provide information to the growing number of backcountry skiers found in areas outside of Tuckerman and Huntington Ravine, and hopefully other winter hikers and climbers often surprised by snow and weather conditions in the range. This season was trial by fire for the forecast team, aided by the public who supported our efforts with snow and avalanche observations as well as with direct donations through the Friends of Tuckerman Ravine. As of May 24th, we issued 164 forecasts with 14 of those being general bulletins, two avalanche warnings, and six avalanche watches. As usual, our primary avalanche problem this season was wind slab, used 119 times followed by wet slab 15 times.

Our largest, farthest running and most destructive avalanches occurred not surprisingly after storm snow accumulated on light to moderate wind speeds over one of several lingering ice crusts. A little wind loading and the resulting slides ripped out mature trees in several of our longer east side slide paths.

Our ski community was crushed on April 11th when an experienced local skier triggered a wind slab on an ephemeral slide path above a tight drainage. Two days of light snowfall totaling only 3" but with strong wind speeds formed the 45cm (average height) by 41m crown which ran on a melt freeze crust formed from a sleet and freezing rain event April 8th. Eyewitnesses and a webcam aimed at the mountain marked the event and subsequent burial at 2 hours and 10 minutes. The victim was buried in a semi-standing position over a meter deep and was unconscious but alive enough to stand up twice before collapsing in cardiac arrest. Continuous CPR efforts were ultimately unsuccessful. In the wake of the incident, hypothermia treatment protocols are under revision by the state as well as local medical helicopter services.

Melt freeze crusts the previous month created conditions which led to the death of an inexperienced winter climber who took a long sliding fall on a 35-degree slope above a boulder field in Huntington Ravine. And outside our SAR response zone, a hiker was killed by falling ice at Frankenstein Cliff during a mid-winter warm up. A missing suicidal hiker who disappeared in our SAR response area on March 8th remains unrecovered.

This season, unusual weather patterns resulted in extremes. Though the winter was atypically warm with very few sub-zero stretches, it was marked by a record number of days with winds over a hundred miles per hour on the summit of Mount Washington. On February 25, the summit recorded a wind gust of 171 mph, breaking the previous February record of 166 mph set in 1972! A record daily high temperature of 37F and a daily record low of -27F were also set that month. The summit received 303" of snow in total this forecast season though 112" of this snow fell in October and November. Our traditionally snowiest months are February and March, which turned out to be pretty disappointing with only 38" and 44" respectively. The lure of deep new snow was strong this year leading to at least 10 unintentionally human-triggered reported avalanches this year, even though overall use in avalanche terrain was low. We presume that low overall use was due

MWAC: Crown profile of a fatal wind slab avalanche. The convex, icy bed surface in the foreground is the likely trigger point for the R4D2 avalanche.

Photo courtesy MWAC



to the intersection of high incidence of weather conditions unfavorable for recreating in avalanche terrain on weekends as well as the positive trend of folks seeking mellow gladed terrain or resorts to play in. Avalanche education and forecasting are likely helping users make better decisions overall, though we continue to brace and prepare for an increase in pressure leading to increased incidents.

—Frank Carus



“It’s a lot easier when the snowpack is predictably unstable rather than unpredictably unstable.”

—2019 Snowball attendee

It’s a common misconception that Turnagain Pass, just five miles from the ocean, is a Coastal snow climate. In fact, over the past 30 years only 12 seasons have fallen into the Coastal category. Hence, persistent weak layers, typically associated with Intermountain or Continental climates, are more often the norm and the challenge. To look more into the nuances for determining when a persistent weak layer transitions from reactive to unreactive in our region, forecaster Heather Thamm worked with 2019 CNFAIC intern Nikki Champion on a project titled “Investigating avalanche release in relation to loading events and snow climate in Turnagain Pass, Alaska“. One interesting finding, using our modest eight-year data set, is during Intermountain and Coastal snow climates, after seven days of no snowfall, 100% of avalanches reported have already occurred. We are excited to build upon Heather’s project season to season and incorporate it into our forecasting tools.

With that said, it was no surprise the 2018/19 season was an Intermountain climate riddled with persistent weak layers. We dodged several bullets as a buried layer of surface hoar, sandwiched between a thin glaze both above and below, wreaked havoc in early February. In one day, four large (D2-3) avalanches were triggered along Seattle Ridge, the most popular riding area at Turnagain Pass. The interesting thing was that the avalanches were only triggered from the ridge. Over 30 tracks and multiple stuck snowmachines were on the slopes minutes/hours before, only to release later when a snowboarder or snowmachine was 30-200 feet off the slope on the ridge; this is where we believe the glaze comes in. The glaze was observed only along the ridgeline on Seattle Ridge and not lower on the slopes. The big forecast challenge was the glaze and ‘reactivity’ of the buried surface hoar was not found in the popular non-motorized areas of Turnagain Pass just across the Seward Highway. Investigating the distribution and reactivity took many days, and in that time conveying avalanche danger was difficult as one side of the road was experiencing deadly avalanches and the other side was not.

After February ended, so did our persistent avalanche issues as March hammered us with one warm and wet storm after another. In 18 consecutive days, 14 were high danger. The month of March began with ~60% of the average

mid-elevation snowpack. By March 14th the snowpack doubled and by March 20th snow turned to rain at the mid-elevations. By late March, not only had the pack shrunk back to its original height, but further diminished and springtime snow conditions were seen a month early. A record avalanche cycle ensued when the snow turned to rain, which was the only saving grace for snow geeks as paths ran for the first time in 20-30 years.

The state of Alaska averages just over three avalanche fatalities per season; this year we had two. We are sad to report that a telemark skier lost their life in the Chugach National Forest in early March after being caught in an avalanche near the Crescent Lake Cabin in the Kenai Mountains. The second fatality occurred when a skier passed away the same week of March outside of Haines, Alaska. March of 2019 also marked a pivotal 20-year anniversary of the tragic accident on Turnagain Pass where six snowmachiners lost their lives in one very large avalanche. This historic accident planted the seeds for the Avalanche Center. To commemorate this day, CNFAIC forecasters held a Meet and Greet at Turnagain Pass to honor those impacted and recognize those who pushed to create what is now the Chugach National Forest Avalanche Center.

The CNFAIC had several operational changes this season. Some of these centered on providing known avalanche concerns in popular areas outside of our forecast zone. We chose to highlight these areas and their concerns within the Bottom Line of the Turnagain forecast. This is an ongoing challenge to solve, yet we were happy with the positive community response. Another improvement was to analyze our forecast product for readability, consistency, and simplicity. Forecaster Aleph Johnson-Bloom worked with a professional editor and regular CNFAIC user to assist with this. We received countless suggestions and ideas to better communicate avalanche danger to the general public. These efforts have been extremely useful! Another exciting change was the installation of a new ridgetop weather station and webcam in the data sparse region of Lost Lake. This region is a highly popular snowmachining area near Seward and a zone we are working to provide more information for.

CNFAIC: These two large avalanches were remotely triggered by a few snowmachiners riding along Seattle Ridge at Turnagain Pass just after a storm. Failure layer was buried surface hoar. However, a unique set-up involving a thin glaze both above and below the buried surface hoar, which extended only along the ridge and upper portions of the slopes, allowed several riders/skiers on the slopes before releasing later by a person(s) on the ridge. Luckily, no one was caught. Photo CNFAIC Staff



Funding for the CNFAIC is roughly a 50/50 partnership between the US Forest Service and the community through our non-profit arm, Friends of CNFAIC. This season the Friends group was able to increase their salary contributions to \$47,250. All three staff members are now fully funded for six months, fulfilling a longtime goal. This season also marks the third year the Friends have hired an executive director. Both the Friends and forecasters have reached over 1,600 people this year through presentations, fundraising and outreach events. Social Media followers increased over 2,000 this the winter for a total of 12,000 and YouTube videos views for 2019 almost hit 5,000. Looking forward, we are excited to launch updates to our website in October 2019, which will include a long awaited mobile friendly platform. It goes without saying, the support from the community, industry, the US Forest Service and our Friends group is vital to our success and we’d like to thank all our donors, members, supporters and volunteers in keeping the CNFAIC pushing ahead. And now, to only find out what snow climate next season has in store!

—Wendy Wagner



The 2018/19 snow season saw the return of El Niño and a relatively warm and wet winter compared to recent years in Alaska. Southcentral was in the crosshairs this year as cycle after cycle brought ample precipitation throughout the region. Many coastal areas saw periods of rainfall at lower elevations throughout the winter. The AAIC produced 454 avalanche advisories and forecasts for the Hatcher Pass, Thompson Pass, and Haines areas supplemented by over 150 snowpack and conditions observations from across the state. These advisories, forecasts, and observations were published to the updated AAIC website viewable at <https://alaskasnow.org>.



AAIC: Aftermath of Haines mid-March major avalanche cycle. Photo Erik Stevens, HAIC

The AAIC continued to collaborate and build partnerships through events like the annual Snow Safety Summit held in Anchorage just prior to the Southcentral Alaska Avalanche Workshop (SAAW.) This year's Summit featured Tyler Aklestad, six-time Arctic Man and 2016 Iron Dog champion, as the AAIC works to further build bridges with the snowmobile community. Participants also heard from CBS news affiliate Joe Vigil from KTVA television with valuable information on communicating with and sharing information effectively with the media.

Our list of partners grew to include Kendall Toyota of Anchorage as a key contributor to the forecasting operation in Thompson Pass. ABC Motorhomes, AARP Alaska, Black Diamond, BCA, Ortovox, Alyeska Ski Resort, Conoco Phillips, the City of Valdez, the City of Palmer, the Haines Borough, Eagle River Polaris Arctic Cat, the Alaska State Troopers, and the Rasmuson Foundation along with dozens of local sponsors who continued to support the AAIC mission through the 2018/19 season. The AAIC was featured in radio, television, and newspaper publication reports throughout the state and continues to build its followership on the social media platforms Facebook and Instagram.

With support from the Alaska Department of Public Safety, State Troopers, First National Bank Alaska and AARP Alaska, the AAIC conducted 58 community outreach workshops, reaching over 5,500 people across the state. The majority of these workshops were delivered to schools where AAIC instructors engaged the next generation of Alaskan winter recreationalists with a fun, exciting, relatable, and most importantly, hands-on introductory backcountry and avalanche safety training. The AAIC also provided two AIARE Level 1 classes at the Prince William Sound College in Valdez.

Tragically, there were two avalanche fatalities in Alaska this season. On March 9th, an Anchorage man was skiing with friends in the mountains on the Kenai peninsula when he was overtaken by an avalanche. Though his partners were able to locate, unbury, and perform CPR on the man, they were unable to resuscitate him. Less than a week later a Haines local snowboarder was caught in an

avalanche. His partners were also able to locate, unbury, and perform CPR to no avail. The AAIC offers its solemn condolences and love to the communities and families affected by these tragedies. Accidents like these highlight the importance of the AAIC community's effort on behalf of backcountry and avalanche safety education.

AAIC STATISTICS:

- 454: Published Forecasts
- 156: Published Observations
- 145,761: AAIC Website Page views
- 62,866: Sessions on AAIC Website
- 27,026: Users on AAIC Website
- 3,698: Facebook Followers
- 1,247: Instagram Followers
- 250: Average Instagram Story Views
- 60+: Education Programs
- 5,000+: Received Avalanche and Backcountry Training 2018/19

CORDOVA AVALANCHE CENTER (CAC):

Overall this winter, warm temperatures began a relatively shallow snowpack. Several strong warm wet storms were interspersed with prolonged dry spells. While a few large avalanche cycles ran with the warm wet systems, any concern about potential persistent weak layers also washed away with the warm and wet. In early March the height of snow grew significantly, but temperatures quickly rose mid-March and within a week, 10 inches of rain fell on our local peaks. The most dramatic avalanche of our season happened at that time above the headwaters of our smaller hydroelectric facility. Presumably, an avalanche dammed the creek for a couple hours, until the snow dam failed. A six-foot wave then traveled down the creek, depositing snow high on the banks for two miles all the way to the ocean. This heavy rain left our shallow snowpack well tested, and continuing warm temperatures seemed to end the avalanche season early. In mid-April, however, winter returned, bringing three feet of new snow above 500 feet. Spring shed soon then began, with mostly small loose events off steep sunbaked slopes. Currently, rain tempts a few looming cornice and glide crack failures. By the time, however, anyone reads this

(if anyone reads this besides me) the avalanche season will be in hiatus and ready to begin again.

—Hoots Witsoe

(Editor's note: Hoots we read every word and wish you an excellent winter of 2019/20!)

EASTERN ALASKA RANGE AVALANCHE CENTER (EARAC)

The Eastern Alaska Range Avalanche Center (EARAC) again placed a focus on bringing education to the interior of Alaska. This fall we made great headway with the snowmobile community, hosting multiple awareness level courses for the snow machine users. To complement this education, we also premiered the Boondockers snow-machine film in town.

In addition to education, our weather station subcommittee made great progress on increasing weather data coming from the mountains. We have done a field site assessment trip with United States Department of Agriculture (USDA), Natural Resources Conservation Services (NRCS) and have permissions to upgrade other existing stations. These will combine to give both ridge top wind levels as well as snow depths in the bowls, which we hope will provide a perfect combination of information before heading into an area without a forecast.

We celebrated the end of the season with the first annual SkiMo Race in partnership with the local downhill ski area in Fairbanks, AK. This event will support future outreach for the EARAC.

The EARAC also hosted an observation contest to encourage backcountry travelers to submit their observations through the Alaskasnow.org website. We received 154 observations as a result of this effort and look forward to expanding this program during the 2019/2020 season.

—Mark Oldmixon

HAINES AVALANCHE INFORMATION CENTER (HAIC)

Winter 2018/2019 was another tough season in Haines. It started out with a decent November snowpack, but the weather just did not bring much snow throughout the winter. Due to unusually high snow levels and a few major mid-winter rain/thaw events, the snowpack at treeline was approximately 58% of average (based on SWE).

2018/19 Weather / Climate Stats:

- 42" of precipitation from Oct-April in Haines (93% of average)
- Driest February on record.
- Least snowy February on record (5" in Haines, 6" at Customs)
- Least snowy winter on record in Haines: 60.5" of snow total (34% of average)

Despite the lack of snow, ski conditions were surprisingly decent in some areas of the Chilkat Pass and north-facing Lutak zone above 1200ft. The dry February actually helped to cause ample surface-faceting, setting us up for a few weeks of soft recycled powder and good stability. That thick layer of surface facets was a harbinger of bad things to come, however, as it was slowly, sequentially buried by 100-150cm of new snow in mid-March, causing a large natural avalanche cycle. Many paths produced 10-year slides, and some seem to have produced roughly 30-year slides. This cycle was quite predictable: slow, gentle loading of the widespread weak layer to large depths, followed by an extreme warm up with heavy new loading and rain-on-snow to act as a trigger. Also

notable were unusually long runouts during this cycle. Some slides ran 2-3+ miles in low-angle terrain, running through that slick facet layer that sat over a hard ice crust, lubricated by free water.

Notable Events:

- We installed (in collaboration with the Yukon Avalanche Association) a new alpine weather station in October 2018. The station is at Haines Pass, British Columbia, and was funded by a Yukon Community Development grant. We are proud to report that in the last 9 years, we have helped bring the number of backcountry weather stations from zero to six, including at least one alpine weather station in each of our three forecast zones.
- We published 101 forecasts from Nov.—April, with a staff of three part-time forecasters/observers.
- We taught a Level 1 Rec. course, and a snowmachine-specific awareness class.
- We also taught 5 free backcountry skills / rescue / beacon practice workshops.

On March 13th, 2019, the community took a hard hit with the death of David Dzenawagis. Dave was well known and active in our local ski community, and regularly submitted observations. The avalanche that took his life was complex, with crown depths that reached three meters in areas. It was rated HS-ASu-D3-R4-O. A full report is available at Alaskasnow.org > Haines > Accidents.

— Erik Stevens

HATCHER PASS AVALANCHE CENTER (HPAC)

Hatcher Pass Avalanche Center had another successful season with growing community support, and a supportive and energetic eight-person advisory board. HPAC significantly increased their conditions reporting through the addition of website based, mid-week summaries. These were produced by two new staff members who lived at the Independence Mine at HP. We provided nearly 50 weekend advisories and mid-week summaries from November through April, with some additional updates after the end of season due to late season snow.

Our social media outreach continues to grow exponentially with regular postings through Facebook and Instagram and proves to be highly valuable for delivering pertinent information quickly to 4,734 followers.

The CNFAIC/HPAC web-based observation platform received 127 Hatcher Pass specific observations this season. Numerous other observations were made through social media venues, HPAC email, and through the good ol' telephone...just leave a message after the rooster crows.

As Alaska warms up due to climate change, we are seeing more 'rain on snow' events, and perhaps the earliest wet cycle we've observed at HP came on March 30th, four to six weeks early. We also experienced long periods of drought with excellent stints of square powder surface conditions, followed by sporadic large dumps with ensuing avalanche cycles.

Two confirmed avalanche burials with successful companion rescues occurred this season, with no injuries. No fatalities this season.

As of May 11, 2019, the Independence Mine Snotel site reports approximately 162" of snow since October 1. We received very minimal snow in October and the IM Snotel site did not begin

accumulating snow until October 28. While October through November precipitation at IM Snotel was slightly above normal, we received most of that as rain. By December 1, our snowpack was 30-40% of normal based on snow course data. We received some big storms in December and by February 1 the snowpack reached 60-75% of normal. Another big storm in February brought the snowpack up to near normal by March 1 (87% SWE). The IM Snotel snow pillow appears to have peaked on March 24, and record warm temperatures across Alaska began melting it out, which would be approximately a month early compared to our records. More snow came in mid-April and by May 10 the IM Snotel SWE peaked again for the season, two weeks later than the norm of April 28th.

HPAC succeeded in funding our non-agency avalanche center through grants, Facebook fundraisers, and our annual cabin fever reliever fundraiser. We were able to pay forecasters in real dollars this season instead of just carrots and moose meat!

HPAC succeeded in our third year of acquiring a loaner snow machine from Alaska Mining and Diving in Anchorage which continues to enable Hatcher Pass forecasters and observers to expand field observations and strengthen our outreach and relationships with the motorized community. The snow machine allowed observers to frequently access areas that were previously out of practical reach by human power (Dogsled Pass, Peters Creek headwaters, Purches Creek, Upper Willow Creek, Lane Hut area).

The annual free HP avalanche rescue workshop continues to be a popular event, with approximately 100 attendees. This workshop is a collaboration between the Hatcher Pass Snow Rider's Club (a local snowmachine group), HPAC, AAIC, Chugach Avalanche Center, Alaska Avalanche School, and the Anchorage Nordic Ski Patrol. The Black Diamond Anchorage Retail Store provided additional loaner rescue equipment. The event includes all user groups, of all ability levels, and is family friendly. The crowd is usually so large that it requires a megaphone to speak, and we teach the "Know Before You Go" curriculum. The event incorporates an old converted school bus with a 10-foot outdoor grill, and is high energy despite being the depth of winter and the sun not yet above the horizon. Many people conduct their first practice rescue scenario ever, are introduced to modern avalanche rescue gear, and given discounts on new gear.

AAIC: Birds-eye view of terrain near Thompson Pass, AK. April 2019 Photo VAC



In addition to the rescue workshop, our HPAC team provided education at six Mat-Su Valley schools.

—Jed Workman and Allie Barker, HPAC

VALDEZ AVALANCHE CENTER (VAC):

For winter 2018/19, the Valdez Avalanche Center issued 60 advisories from December through April; the forecasting position is currently split between three people over the course of the season. Daily observations were recorded at the Blueberry Study plot and forwarded to the National Weather Service.

The freezing level throughout the area was higher in elevation than average, and wind was less of a driving factor in our avalanche problems than in previous forecasting seasons. The advisory area had a significant avalanche cycle in late March with no fatalities. Over the winter, Thompson Pass received 421" of recorded snow with 58" SWE. Valdez received 158" snow with a 52" SWE.

For the third year, from March 15—April 15, VAC staff manned a temporary information kiosk near Thompson Pass where, three times weekly, we offered free educational courses and forecasting information. This was made possible with support from the City of Valdez and ABC Motorhomes who donated temporary housing for the forecasters. In addition, the team provided several other avalanche awareness and rescue courses to elementary, middle, and high school groups.

Changes for the season included: advisories published three times per week instead of seven, a new website, a two-year lease donation of a Toyota truck thanks to a sponsorship from Kendall Toyota of Anchorage, and the creation of the Valdez Avalanche Center Instagram page.

This is the sixth year the City of Valdez has allotted funding through the Community Service Organization program for Valdez Avalanche Center. Private businesses and individual member donations have enabled the program to grow from a volunteer effort to paying qualified, trained forecasters and observers for their work.

— Ryan Van Luit, Peter Biskind, and Sarah Carter

The AAIC staff strives every day to support the work of regional avalanche centers and interested communities in Alaska through resource and information sharing, education, and research. ●

AVALANCHE AIRBAGS AND THE ABILITY TO CREATE AN AIR POCKET AND DELAY ASPHYXIATION

BY SCOTT MCINTOSH, NATALYA POLUKOFF, COLIN LITTLE, THOMAS SEIBERT, & COLIN GRISSOM

Avalanche airbags are designed to propel a skier or rider to the snow surface using the physical property of granular convection, also known as inverse segregation. In a mixture of varying sized particles, granular convection lifts larger particles towards the top of the mixture while smaller particles fall towards the bottom. The primary goal of an avalanche airbag is to prevent a critical burial, defined as head and oral cavity under the snow. Mortality is over 10 times higher in critical burials than non-critical burials. [Brugger 2001]

Airbags do not always accomplish the intended goal of keeping the victim at the surface, however. Approximately 20% of avalanche victims who successfully deploy their avalanche airbags become critically buried. [Haegeli 2014] This may occur due to a large avalanche, terrain trap, or other unfavorable burial circumstances. One avalanche airbag produced by Black Diamond Equipment, Ltd, Salt Lake City, Utah, actively deflates three minutes after deployment; the fan reverses and removes the air that has inflated the airbag. The goal of this deflation is to create an air pocket under the snow. Our study examined the potential of active deflation to form an air pocket and measured minute-to-minute physiology under these circumstances. An air pocket could act as a secondary safety measure in the event that a backcountry user becomes critically buried. We hypothesized that the air pocket created by active deflation would provide sufficient conditions to maintain normal physiology for a 60-minute study period.

These results support the hypothesis that the air pocket created by active deflation created adequate conditions to maintain normal physiology for a 60-minute snow burial period.

Participants estimated they were able to move their head forward on average 11.2 cm forward and backward 6.7 cm. Participants reported the following when asked about their ability to move their face away from snow: Strongly agree=5, Agree=6, Disagree=1.

These results support the hypothesis that the air pocket created by active deflation created adequate conditions to maintain normal physiology for a 60-minute snow burial period. The data show that if an individual using an avalanche airbag is critically buried, the active deflation mechanism can create an air pocket beneath the snow that substantially increases the time before succumbing to asphyxia. Of course, these were experimental and ideal conditions. Participants had a mouthpiece and experimental tubing in place so that we could measure gases and EtCO₂ concentrations. If a real victim's airway were packed with snow during the avalanche, the air pocket would be useless. Trauma could kill an avalanche victim at the outset.



Figure 1. Participant placement before burial, after inflation, and after complete burial.

The experimental design modeled a critical avalanche burial. Twelve healthy, paid volunteers were the subjects of the study. Most avalanche victims end up in the prone position with their head downhill, so participants were positioned in a snow trough in the prone position. Once positioned, the participant deployed the avalanche airbag. The participant was buried within 60 seconds of inflation in approximately 130 cm of snow. Participant vital signs were continuously monitored: oxygen saturation, end-tidal carbon dioxide (EtCO₂), heart rate, and respiratory rate. EtCO₂ is the amount of exhaled carbon dioxide. Rising EtCO₂ levels and lowering oxygen levels lead to asphyxiation during avalanche burial. Following extrication, participants completed a survey with the following questions: (1) How many inches do you estimate you were able to tilt your head forward after the airbag deflated? (2) How many inches do you estimate you were able to tilt your head back after the airbag deflated? (3) After the airbag inflated, I could pull my face away from the snow in front of my face. These questions were asked on a scale of "Strongly agree" to "Strongly disagree" and helped determine whether someone could access the air pocket created by the deflated airbag.

Overall physiology measurements did not change significantly over the burial period, except EtCO₂. Even so, EtCO₂ measurements remained within the normal physiological range (35–45 mmHg), for all participants except one participant (which measured 50 mmHg on extrication). This participant needed to be extricated at 48 minutes due to increasing EtCO₂, increasing heart rate, and anxiety. All other participants remained buried for the full 60-minute study period.



Figure 2. Example of the air pocket created by deflation of the airbag observed upon extrication.

Certainly, sound decision-making is the most reliable method to mitigate risk in avalanche terrain. Individuals traveling in avalanche terrain should educate themselves in terrain choice and be highly efficient in rescue procedure. In the very real circumstance that an avalanche victim is critically buried with a free airway, however, the deflation mechanism could delay asphyxiation and create circumstances that might give a partner or search and rescue team adequate time to unbury the victim alive. Our study suggests avalanche airbag active deflation can serve as an additional layer of safety for individuals traveling in avalanche terrain. ■

Scott McIntosh, MD, MPH is an emergency and flight physician at the University of Utah and an avid backcountry skier and mountaineer.

Natalya Polukoff, BS is a first year medical student at the University of Utah and enjoys skiing, mountain biking, and campfires.

Colin Little, MD is an Emergency Medicine physician specializing in wilderness medicine and search and rescue, completed a Wilderness Medicine Fellowship at the University of Utah, and currently works for OHSU in Portland, OR.

Thomas Seibert, MD, MS is a Colorado native, backcountry skier and Wilderness Medicine physician with goals of ski patrol medical directorship.

Colin Grissom, MD is the Senior Medical Director for Critical Care, Intermountain Healthcare, Utah

BOOK REVIEW

BY CHRISTINE HENSLEIGH

When **Susan Purvis** decided to train an avalanche puppy, Tasha, she did it in a big way. First, learn all she could about working in avalanche terrain. Next, learn puppies and dog training. As a first-time dog owner of a black Labrador, this was no small feat. Finally, navigate the macho world of patrol, search and rescue and ski town politics.

It was a goal that started in the wake of a tragedy during avalanche season—the burial of three toddlers and the inability to recover the last body with a trained avalanche dog. Purvis was between expeditions and looking for something more. Back then she was splitting time between hunting for gold in the Dominican Republic and skiing in Crested Butte, Colo. That story put her in mission mode and defined the next two decades of her life, fueling a simple desire that anyone active in search and rescue can appreciate: saving lives.

She and Tasha became the first female dog team in her avalanche-prone county to certify in wilderness, water and avalanche rescue, receiving Congressional Recognition for her work in avalanche search and rescue. That quest is also the subject of her memoir, *Go Find: My Journey to Find the Lost—And Myself*.

“Six years into our tenure Tasha and I were the team to call in central Colorado,” she chuckled. “We were the clean-up crew. When search and rescue teams couldn’t find the missing, Sheriff’s departments called us.”

The quest also buried her in the process. In the wake of success, Purvis also discovered she was sit-

ting in a tremendous personal void, as devastating as any avalanche.

“My husband left, my dog died, and I thought I was going to suffocate. I was so lost...buried so deep and unable to move, it was like an avalanche. I discovered in the writing process that I was as lost as any victim I’d ever found.”

The only way to escape, she would find, was to write herself out of it. After a move to Whitefish, Montana and a 10-year commitment to learning the art and craft of storytelling, Purvis emerged with a book and a book deal. What started as a story of a woman, a dog, and an avalanche turned into much more.

But before Purvis and Tasha made it, she had to learn about avalanches. She learned that from a savvy set of instructors and mentors at AIARE. Like all things serendipitous, her introduction to AIARE and its educational programs, started with a conversation with AIARE’s Tom Murphy near an avalanche zone over—what else—dogs. Specifically, black Labradors. Tasha was still a puppy and Tom had two older labs. He knew that getting Labs to do something was a challenge; he’s had three.

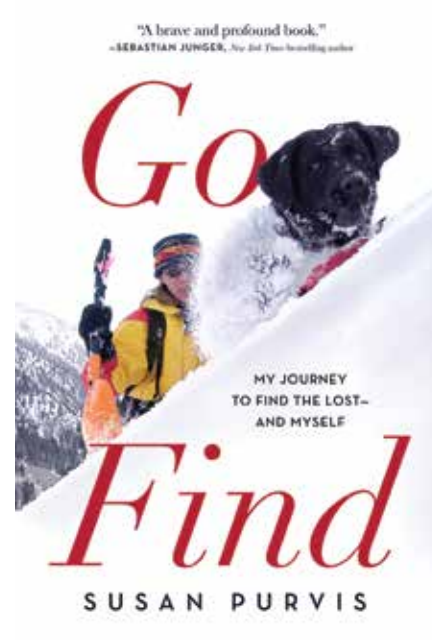
Her passion for learning about avalanches got his notice, his started in Alaska decades before. He took her wilderness medicine course and was impressed. She attended one of the first AIARE courses on avalanches and kept taking them.

In life, as in books, there are good guys and bad guys. And for Purvis, those AIARE mentors and backcountry experts who helped were the good guys of her world and the backbone of all of the avalanche knowledge she now shares. A cadre of men who gave her the security to go with them into the backcountry and learn from life’s most seasoned instructor: experience.

“Their attitude was ‘whatever you need we are here for you. It was so different than the ski world I was in. They trusted and believed in me. It was the first time someone said ‘we’d love to have you,’ Purvis noted, admitting, “They carried me through the first few years. I didn’t know anything about avalanches.”

Her non-fiction adventure has all the avalanche missions you could want, a helpful guide of sorts.

“I thought dog training was pretty simplistic until I read the book. The way scent moved. I wouldn’t have



known that. There is a complexity to it. Sue mastered that,” Murphy observed

It is also much more. As anyone in the book business will tell you, if you’re writing memoir, you have to give the nitty gritty details. Saving someone from an avalanche—that’s great non-fiction, it’s not a memoir. Memoir is personal.

“After I thought I had submitted a completed manuscript, my agent made me go back tell more of the story, reflecting back from different people’s perspective and the lessons I learned,” Purvis explained.

It took four more months of writing before Purvis got the right amount of detail. Her hard cover published last fall and the paperback comes out this fall. Her year was a whirlwind of book stores, mountaineering shops, film festivals, and speaking at author’s conferences.

Taking those last few months paid off in emotional connection with her audience. Mostly men and a few women stay late, tears in their eyes, to talk to her about their own feelings of being one of the lost.

Through the 10 years of writing, and rewriting, Purvis continued to teach and still teaches Wilderness Medicine and AIARE Avalanche courses through her outdoor education company, Crested Butte Outdoors.

She is still, at heart, like everyone in search and rescue—just trying to help out in tough situations. Even when it comes down to being an author.

“I’m here to share my story so other people won’t get lost or buried in their own metaphorical avalanche. I want to help so that people don’t get buried like I did.” Purvis explained. ●

Christine Hensleigh is an outdoors writer in Northwest Montana. Her online publication about the lore and history of Glacier Park and the surrounding towns is glaciergazette.com



House of Representatives

PAYING TRIBUTE TO SUE PURVIS AND TASHA THE SEARCH DOG – HON. SCOTT McINNIS
(Extensions of Remarks - June 19, 2003)

HON. SCOTT McINNIS
OF COLORADO
IN THE HOUSE OF REPRESENTATIVES
June 19, 2003

Mr. Speaker, I would like to pay tribute today to a woman and her dog who willingly give their time to provide assistance to others. Sue Purvis and her search dog Tasha of Crested Butte, Colorado volunteer to help locate victims of avalanches. In doing so, they help bring closure to victims' families and perform a public service to their community.

During one week in March of this year, Sue and Tasha were called to the scene of two avalanches. The first trapped a 33-year-old man who had been caught in a slide while snowmobiling. Some 30 rescuers searched unsuccessfully for several hours before calling in Sue and Tasha. Together, working with another canine search team, they found the man's body within half an hour.

A few days later, the pair received a call involving another snowmobiler. This time, the victim triggered a massive slide 10-feet deep and several hundred feet wide. The slide packed so much power that the debris field was 20 feet deep and contained chunks of snow and ice the size of a van. Despite working by themselves, Sue and Tasha found the man's body buried in six feet of snow about an hour later.

Mr. Speaker, when Sue and Tasha venture off into the Colorado backcountry to search for victims, they often enter very unstable and dangerous snow conditions. Still, they do so willingly to help bring closure to the victim's families as quickly as possible. That unselfish spirit of neighbor-helping-neighbor is what helped make this country great, and I am truly honored to have the opportunity to honor Sue and her amazing search dog Tasha here before this body of Congress today.

CONTRIBUTORS



In 1980 **Bruce Jamieson** started hauling toboggans and working on a small forecasting team for a ski area with large avalanche problems. After six winters with two ski areas, he began graduate studies at the University of Calgary, focusing on field studies of avalanches including snowpack tests. As a professor of Civil Engineering from 1997 to 2015, Bruce managed field studies of snow and avalanches. The research program attracted a remarkable team who had their heads and hands in the snow daily. Now, he works as an avalanche consultant and educator.



Dave Richards was born and raised in the Wasatch Mountains of Utah. For the past 19 years Dave has worked as a full-time Alta ski patroller and has been the director of the Alta ski area avalanche office for five seasons. He has also worked as a helicopter ski guide for Wasatch Powderbird Guides, as an avalanche rescue dog handler, and is a member of Wasatch Backcountry Rescue.



Roz Reynolds, originally from Boise, Idaho, moved to Colorado to study Civil Engineering, but soon changed career direction to work as a climbing and ski instructor. Currently managing the US branch of Wyssen Avalanche Control, she now lives in Boulder, Colorado, where she enjoys skiing and climbing in the surrounding mountains. Her work and personal travel have taken her to unique places around the globe and she enjoys working in an industry that strives to make mountain travel and recreation safer.



Alex Marienthal is a forecaster for the GNFA whose favorite hobby is ski patrolling at Bridger Bowl. He has an uncanny ability to navigate in whiteout conditions on a snowmobile, and is one of the great lyricists of our time

Andrew Schauer was the intern at the GNFA last winter while he completed his Master's degree in Snow Science at Montana State. He is an expert telemark skier and banjo player. What he lacks in adequate gear is made up for by his keen snow sense and good humor.

Spencer Jonas reading up before guiding. Photo Drew Pogge



ISSW 2020

Fernie, British Columbia  CANADA



MATT KUHN PHOTO

OCTOBER 4-9, 2020

Visit issw2020.com







SUPPORTING SPONSOR




PRESENTED BY




Explosives EXPERTS Explosit



NATIONAL SUPPORTING SPONSOR



REGIONAL SNOW AND AVALANCHE WORKSHOPS

- October 4, 2019** — Colorado Snow & Avalanche Workshop — Breckenridge, Colorado
- October 4, 2019** — American Avalanche Association General Membership Meeting — Breckenridge, Colorado
- October 9, 2019** — Montana State University Snow and Avalanche Workshop, Montana State University, Bozeman, Montana
- October 19, 2019** — Eastern Snow and Avalanche Workshop, Fryeburg Academy, Fryeburg, Maine
- October 20, 2019** — Northwest Snow & Avalanche Workshop — The Mountaineers, Seattle, Washington
- October 26, 2019** — Wyoming Snow & Avalanche Workshop — Center for the Arts, Jackson, Wyoming
- October 26, 2019** — Four Corners Snow and Avalanche Workshop — Silverton School, Silverton, Colorado
- November 1-2, 2019** — Utah Snow & Avalanche Workshop — Mountain America Expo Center, Sandy, Utah
- November 2, 2019** — California Snow & Avalanche Workshop — North Tahoe Events Center, Kings Beach, California
- November 8, 2019** — Southcentral Alaska Avalanche Workshop — Alaska Pacific University, Anchorage, Alaska
- November 9, 2019** — Bend Snow and Avalanche Workshop, Central Oregon Community College, Bend, Oregon
- November 16, 2019** — Northern Rockies Snow & Avalanche Workshop — O'Shaughnessy Cultural Arts Center, Whitefish, Montana
- March 30, 2020** — Sawtooth Avalanche Center Professional Development Seminar — Ketchum, Idaho
- April, 2020** — Gallatin Professional Development Seminar — Bozeman Public Library, Bozeman, Montana



Explosives
EXPERTS
Explosives

WWW.CILEXPLOSIVES.COM/AVALANCHE



Emulex emulsion cold weather Avalanche Charge. Available with cap well in 2" by 16" and 2.25" by 12". Tested to -40



Hermetically sealed Trilaminate bag ensures long, high performance life of 90 sec, 1m, 2m, 3m MILDET Safety fuse - The Gold Standard

**ASK BRADEN ABOUT
OUR NEW SNOWLAUNCHER GUN
THE
"CIL IMPERIAL"**



Stay a step ahead with Custom CIL Avalanche Control Products

*When you request CIL explosives you are supporting your industry!
a percentage of all purchases go to the American Avalanche Association for training purposes*

Contact : Braden Schmidt 250 423 3302 braden.schmidt@cilexplosives.com

//// AVALANCHE HAZARD CONTROL MANAGEMENT



TAS is the world leader in prevention systems for avalanche risk management. The company designs and manufactures gas RACS (Remote Avalanche Control Systems) without explosives use and avalanche barriers. TAS also offers advanced monitoring solutions in order to anticipate, analyze and control the global avalanche activity.



MND America
PO Box 2167 063 Eagle Park E Dr Eagle CO 81631 - 2167. UNITED STATES
www.tas.fr - www.mndamerica.com

Our partners:



THE AVALANCHE REVIEW
PO Box 7019
Bozeman, MT 59771

PresortStandard
US Postage Paid
Permit #592
Pontiac, IL

A Publication of the
American Avalanche Association



AMERICAN
AVALANCHE
ASSOCIATION